Forest Economics and Finance

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THIS book is dedicated to H. G. B., conservationist in her own right, who put aside her own professional work for long periods to assist in the collection and preparation of data for this book.

PREFACE

The purposes of this text are:

1. To present a unified discussion of the economic and financial aspects of American forestry based on modern economics, a knowledge of which is part of the professional equipment of every forester. Forestry does not function in an economic vacuum but is part of a closely integrated structure of production and consumption. Such a treatment seems to be needed, first, because there is no general work on forest economics available; second, because the existing textbooks on forest finance, while excellent, are rather too advanced for the average student; and, third, because forest finance is, in the last analysis, merely a specialized branch of forest economics.

2. To include considerable material dealing with the economic and financial nature of forest exploitation and of the forest industries. Forest economics and the economics of forest industries are as closely related as the Siamese twins and as difficult to separate.

3. To consider the economic aspects of protection, recreational, and wildlife forestry, which are becoming important enough to merit more economic analysis than they have hitherto received.

Since the average forestry student is none too well grounded in economics and lacks practical experience or theoretical training in even the more elementary aspects of business and finance, the treatment in the early chapters is somewhat elementary, being designed to remedy this deficiency and to lay a sound foundation for the later chapters. Since no combined treatment can go into the minutia of both economics and finance, much advanced material has had to be omitted. It is hoped that emphasis on the integrated nature of the two subjects will compensate for the omissions.

Many general discussions of forest economics are almost indistinguishable from forest policy. The writer considers the latter to be concerned with economics only as it affects and is affected by economic factors. Obviously, forest policies should be set up and judged in accordance with their social and economic effects, but it is not the function of economics to do more than point out the implications of various public and private policies. In the last analysis, every forester must draw his own conclusions on the great questions of forest policy.

Although this book is designed primarily as a textbook, the attempt has been made to present enough background material regarding forestry in general to make it useful to economists and others seeking a better understanding of the broader aspects of forestry questions. It is believed that it will also be useful not only in schools where forest economics and forest finance are taught as a single course but also in schools that give separate courses in each subject. In the latter type of school the finance instructor may easily combine the strictly financial material in the later chapters with that in the earlier ones, and the economics instructor can cover the rest of the book. Although the textbook is not designed as one on forest policy, much factual material for such a course is presented in Parts I and II and enlarged upon in Part III. It is therefore believed that the book can be used to advantage as a basis for such a course, the instructor requiring outside reading and interpolating such material as seems necessary to bring out other than purely economic aspects of forest policy.

No problems in forest finance are included because the instructor naturally will prefer to make up his own, varying them from year to year. The writer found it useful in teaching to require the students to look up the figures in published sources and to solve problems in terms of the figures thus obtained. This not only took the problems out of the sphere of entirely mathematical exercises but also familiarized the students with original economic and financial studies.

Any writer on a technical subject owes more than he can express to other workers in the same field. Much of this debt cannot be expressed even in a bibliography, but the specific debt should be acknowledged as far as possible. Foremost on this writer's list comes Gordon D. Marckworth of the University of Washington, who, while Director of the School of Forestry at the University of Georgia, gave the writer not only permission but also encouragement to conduct the type of course out of which this textbook developed. To the following members of the faculty of the Yale School of Forestry the writer is specifically indebted: Samuel J. Record, for free use of Yale's extensive library and for working quarters during the later stages of the work; H. H. Chapman, for reviewing many of the chapters and for unlimited man-hours of profitable discussion; Walter Meyer, for a critical review of practically the entire manuscript; G. A. Garratt, for constructive criticism of Chapters X and XII.

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P. L. Buttrick

New Haven, Conn.
January, 1943

REFERENCES AND BIBLIOGRAPHY

No general work can hope to list all useful references, much less indulge in a complete bibliography, although some references are required. Two systems of referencing have been used in this book. For those chapters for which there are standard sources, there is a reference list appended. Other chapters have footnotes to references of importance to particular points. In the earlier chapters any standard textbook on economics is a sufficient reference.

For an exceeding valuable bibliography of the economic aspects of American forestry, the reader is referred to Alf Z. Nelson's *A Selected Bibliography on the Economics of Forestry in the United States,* published October 1, 1941, by the United States Forest Service, Washington, D. C.

CONTENTS

PART I

THE ECONOMIC AND FINANCIAL BASES OF FOREST ENTERPRISES

PART II

SPECIAL ECONOMIC FACTORS IN FORESTRY

PART III

FORESTRY AS A PRIVATE AND A PUBLIC ENTERPRISE

TABLES

FIGURES

PART I

THE ECONOMIC AND FINANCIAL BASES OF FOREST ENTERPRISES

CHAPTER I

INTRODUCTION

Every single operation in forestry, from the largest to the smallest, is immediately or remotely controlled by economic and financial considerations. Trees grow by processes of nature, which are only partly, and always indirectly, under man's control, but it costs money to acquire, establish, improve, protect, harvest, and secure the reproduction of a forest. The only reason for the expenditure of this money is to increase, directly or indirectly, private or public wealth and well-being. If the forest is a private one, the objective is, ordinarily, to make money for the owner; this money in one way or another benefits other individuals besides the owner. If the forest is a public one, the objective is to increase the public welfare, for the benefits are shared directly or indirectly by the entire population.

1. SCOPE

Forest economics and *forest finance* are those branches of forestry which treat of the economic and financial aspects of the establishment, care, harvesting, and general economic usefulness of forests. Sometimes they are considered as one subject, sometimes as two. Forest economics when treated by itself is generally concerned only with the broader economic value of forests to mankind or with statistics of forest areas, amount and value of forest products, and similar data.

Finance as a general subject may be thought of as that branch of economics which treats economic factors in terms of money and accounting. Forest finance in its special field covers these same factors in similar terms. The specific task of forest finance is the consideration of forests and forestry as business and investments, both in general and as applied to particular areas and conditions.[1]

In practical affairs it is impossible, except in a limited way, to consider economics and finance as separate entities. Consequently, a unified treatment of the two subjects is attempted here. Both subjects are closely related to a third subject, *forest policy*, which may be de-

[1] Forest finance sometimes is divided into two branches: forest *valuation*, which is concerned with the valuation of forests, and forest *statics*, which compares the financial results of different methods of treating forests. This division is of little practical importance.

fined as the study of the basic ideas, laws, or customs underlying the handling of forests in different times and places. As a tabloid example, it may be said that before the first World War it was the policy of the British government to put most of its efforts in forestry into work in the dominions and colonies, neglecting the British Isles almost entirely.

Forest policies are supposed to be based on sound economic and financial considerations but, on the other hand, are not infrequently based on political considerations which may be economically unsound and hence socially unwise, as the British policy turned out to be during 1914–1918, when England's vital timber imports were almost cut off by the German submarines.

2. RELATION OF THE ECONOMIC TO BIOLOGICAL AND ENGINEERING ASPECTS OF FORESTRY

Forest economics, finance, and policy fall naturally into the *economic group* of forest subjects. There are two other groups, the *biological* and the *engineering*. Therefore, all forestry subjects can be classified as follows:

CLASSIFICATION OF THE BASIC FORESTRY SUBJECTS AND THEIR BASIC SCIENCES

Biological Group	Biology (the basic science of the group) Botany Dendrology Wood Technology Pathology (Forest) Entomology do. Zoology do. Silvics Silviculture
Engineering Group	Mathematics (the basic science of the group) Surveying Mensuration Various engineering subjects necessary for solution of special forest problems
Economic Group	Economics and sociology (the basic sciences of the group) Forest Economics Do. Finance[1] Do. Policy Do. Management Do. Administration

[1] Forest finance, to the extent that it uses mathematical technics in accounting, is sometimes considered as belonging in the mathematical group.

It will be noted from the above classification that silviculture falls last in the biological group, mensuration and various engineering subjects last in the engineering group, and management and administration last in the economic group. These three subjects are the working tools of the forester in the woods. *Forest management* is that branch of forestry which attempts to apply the combined knowledge and technics of silviculture, engineering, economics, and finance and to assemble them into an organized plan of operations for the particular forest or group of forests upon which the forester is working. If any one of them is not properly applied, the structure will not stand, any more than two legs of a tripod will support a transit. *Forest administration* is the carrying out of the plan of management and the day-to-day conduct of forest operations and ordinary forest business.

3. CONTRASTING ECONOMIC VIEWPOINTS REGARDING FORESTS

Economics revolves around two main poles, production of goods and their consumption, and nearly every economic problem may be approached from either standpoint. The social success of an economic system may be judged by the degree to which these two factors are in proper adjustment, so that goods of all kinds are produced and consumed in sufficient volume to meet the financial and material needs of all.

Forest economics, therefore, must approach its problems (1) from the point of view of the proper utilization of land suited to forests in relation to lands suited to other purposes. In this respect it becomes a branch of *land economics,* which studies the uses of lands for all purposes with the view to securing their proper functioning for all economic and socially desirable purposes. (2) Forest economics must approach its problems also from the point of view of the proper distribution and use of the various products and services of the forests, whether timber, wild flowers, waterpower, or recreation. This is the viewpoint of consumption rather than production. Its economics revolve around the pole of demand and ordinary marketplace considerations. Although both points of view involve both public and private considerations, those problems relating to fitting forests into their proper place in general land use have more of a public nature, while those of supply and demand are usually considered to be in the sphere of private enterprise. It is necessary to understand both the aspects of land use and of the consumption of products in all their necessary interrelations, remembering that one is incomplete without the other and that the objective is to work out the proper relation between them.

4. THE OBJECTIVES OF FORESTRY

Forestry may be practiced with one or more of the following objectives: (1) To produce timber crops, called, for the lack of a better term, *timber-production* forestry; (2) to protect lands from erosion, avalanches, high winds, or to conserve water supplies—consequently, it is called *protection* forestry; (3) to provide recreation places for public or private use. Usually they are called parks if publicly owned or estates if privately owned; (4) to provide habitats for wildlife, usually known as *wildlife sanctuaries* or *game reserves*. All these objectives can be and often are combined on large public and, occasionally, on private forests. Such forestry is known as *multiple-purpose* forestry, although one objective is likely to be the primary one.

The economic considerations involved in these different types of forestry are dissimilar. In timber-production forestry the economic objective is to secure revenue from the timber crop or to supply a public need for wood products. The economic objective of protection forests is to protect or increase the value of other natural resources such as land or water.

Recreation forests, if publicly owned, serve a social rather than a direct economic purpose in that they minister to public health and enjoyment. They may, however, have an indirect economic value to the communities in which they are situated. Occasionally they are a local economic handicap. When privately owned, they are operated sometimes for profit from the rental of use privileges. More often they belong to wealthy owners who handle them on a luxury basis.

These remarks apply almost identically to forests that are treated for purposes of wildlife conservation. Any timber that is cut from recreation and wildlife forests is cut with the objective of increasing their usefulness for their intended purposes rather than for profit, although an actual cash profit may be realized from the sale of the timber. The cutting on protection forests must be limited to an amount which will not destroy their usefulness for their major purpose. Moreover, such forests frequently are located on steep slopes or poor soils, where the growth rate is slow and logging costs high. Usually these facts take them out of the class of important timber producers.

When it is necessary or desirable to mix one or more of these last-mentioned types of forestry with timber-production forestry, it generally involves, more or less, loss of income from the sale of timber as well as greater cost of administration. However, forests, well situated as to markets and having low production costs, may be able to carry

the expense of minor recreation areas and make small concessions to game management.

In view of the fact that the economic importance, the extent of practice, and the economic complexities of timber-production forestry far transcend all the other kinds of forestry, the bulk of this text will deal with this branch. When the word "forestry" is used, "timber-production forestry" [1] will be implied; other types will be referred to by name.

5. THE ECONOMIC RELATION OF FORESTRY TO LUMBERING

Exclusive of forests that are used solely for protection, recreation, or wildlife purposes, forests are produced or protected for the purpose of later removing the mature trees as raw material for all the various purposes to which they can be put. This process of removal is called *logging* or *lumbering*. If no attempt is made to secure reproduction when this operation is carried on, the process is economically comparable to mining and has no relation to forestry. If all the merchantable material is removed at one time, the process is called *liquidation*. If, on the other hand, it is carried on with the intention of leaving the stand in condition to immediately start producing another crop, either by planting or by controlled natural reproduction, the operation is analogous to harvesting an agricultural crop and becomes a step in forestry operations.

Whether lumbering is carried on as a mining or a harvesting operation, it is subject to economic and financial considerations. These considerations are by no means the same as those involved in the practice of forestry, that is to say, the growing of timber crops, but there are many relations between them, particularly when logging is practiced as a harvesting process. It is, therefore, necessary to understand adequately the economic and financial aspects of forestry in order to have some knowledge of the economic and financial aspects of lumbering and other forest industries. It is equally important to keep the distinctions between the economics of forestry and those of lumbering clearly in mind.

Various forestry technics may be used in lumbering (mensuration, for instance); foresters may be employed in these operations, and to the general public forestry is coming to mean anything connected with the woods. But true forestry is not being practiced unless operations are carried on with the definite intention of producing another crop

[1] The word "timber," as used in this text, covers all wood and wood-derivative products. This usage is entirely for convenience. The term *economic* forestry is sometimes used as equivalent to timber-production forestry on an economic basis.

of timber on the same area.[1] In order always to be sure which is being referred to, it is well to speak of logging not connected with forestry as *timber mining, destructive logging,* or *liquidation cutting,* and that carried on in connection with true forestry as *harvesting.*

6. ECONOMIC RELATION BETWEEN FORESTRY AND GRAZING

Grazing has been conducted in forests from time immemorial, particularly in coniferous forests in regions of low rainfall where the trees are apt to be widely spaced and the intervening areas covered with forage grasses. In early times, and even today in pioneer communities, such forests often are locally considered of more economic importance for their forage than for their timber or protective value.

When carried on to a moderate degree, grazing does little or no harm to these forests and may even prove somewhat beneficial by reducing the fire hazard as well as by giving the young trees a better chance to become established. If an excess of stock is crowded upon the area and if it is regularly or periodically burned, as frequently happens, the practice almost inevitably results in the destruction of the young trees, so that when the old ones die or are destroyed the forest ceases to exist. In some parts of the world the destruction of valuable forests by grazing has been enormous. Central Spain is an outstanding example.

Under proper regulation, grazing and timber production may be carried on without serious loss to either practice. However, there have been and probably will continue to be serious economic clashes between those dependent upon grazing in a particular region and those dependent upon or interested in forest production in the same region, neither party being willing to make the necessary sacrifices or to submit to the necessary regulations to permit both practices to be carried on successfully. The clash has usually occurred in regions where the grazing industry had become established before the value of the forests for timber was evident. Later, those interested in perpetuating or expanding the forest resources faced the entrenched opposition of the grazing interests who did not wish to have their operations curtailed in any way. This struggle, like all economic struggles when they reach a certain intensity, has usually been transferred to the political arena, and not infrequently in remote regions it has become a struggle where armed force has played its part.[2] Such struggles have not been infre-

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[1] Under certain favorable circumstances satisfactory reproduction may follow logging when no attempt is made to secure it (Chapt. X, Sec. 7).

[2] P. L. Buttrick, "Politics and Perpetual Rights," *Journal of Forestry,* Vol. XXVI, No. 1, January, 1928.

quent in the history of many parts of the American West and also, though to a much less extent, in the southeastern United States.

7. CONTRASTING VIEWPOINTS OF PRIVATE AND PUBLIC FORESTRY

Forestry may be and is practiced by either public or private agencies although, owing to the peculiar nature of economic and social factors which bear upon it, it is more largely a public than a private enterprise in most countries.

Obviously, with minor and insignificant exceptions, the social value of the enterprise, arising from providing labor opportunities, land reclamation, etc., can have no weight in financial calculations although, as individuals, those engaged in the enterprise may rejoice in the community benefits it effects. Likewise, private owners cannot be expected to engage in forestry unless the enterprise shows evidence of being profitable to them; it is not enough that it benefits the community at large.

Forestry as a public enterprise does not necessarily need to show a direct financial profit in order to justify itself. Its justification may be the economic advantage to the public of providing an abundant supply of an essential raw material even if it costs more to produce than it sells for, or it may be justified by an indirect economic benefit through watershed protection, erosion control, and the like. Public forests may be, and in European countries often are, operated at a financial profit. The public forests of Sweden are said now to yield a considerable direct financial return to the national treasury.[1] In the United States the bulk of national and state forests cannot be expected to yield an immediate profit because the cost of establishment or purchase, the installation of necessary improvements, and frequently the necessity of building up depleted or burned-over stands is too great. It is possible that, as time goes on and the stands improve in quality, the heavy initial costs may be paid off and the forests may yield a profit.

The fact that public forests are usually not able or required to show a direct financial profit does not take them out of the field of forest finance. It is just as necessary to secure funds to expend on establishment, improvements, and protection, and just as imperative for the public good that these funds be economically expended as it is that

[1] From 1909 to 1924, inclusive, the national forests of Sweden had an average annual net income of about $4.25 million, which amounted to about 6 percent on their valuation. G. S. Perry, *Forestry in Sweden and Adjacent Lands*, p. 138. Table LVII, 1929. Privately printed, Mont Alto, Pa.

funds be raised and properly expended on private forests, even though the final balance is public good on the one hand and black figures in the ledger on the other.

8. EXTENT OF THE PRACTICE OF FORESTRY

Unfortunately, it cannot be said of all countries in the world that either public or private forestry is as large an enterprise as it could or should be. The fundamental reasons for the slow progress of both are: There are still enormous untapped forest resources in various parts of the world, and the growing of timber involves a long-term investment and a considerable element of risk due to various causes. These reasons have caused private capital to be wary of heavy investment in forestry. Public forestry has made its chief appeal on the basis of the public need for forest products and the necessity for protection of water supplies, prevention of erosion, and the recreational uses of forests. Its progress has been most rapid in those countries having a combination of enlightened leadership and sufficient wealth to finance the necessary large-scale operations.

9. FOREST ECONOMICS IN RELATION TO GENERAL ECONOMICS

Both forest economics and forest finance are specialized branches of general economics and finance, and they cannot be understood without some understanding of basic economic and financial principles. Forestry and the forest industries must operate within the general economic system and are influenced by everything that influences economic life. They, in turn, exert their influence on economic activity in general.

In this text the endeavor is to keep this always in mind, first, by giving over most of Part I to link forestry and the forest industries to the simpler economic phenomena; second, by discussing the more complex aspects of forestry which differentiate it from other common economic phenomena (Part II); and third, by bringing both together in a discussion of forestry as a public and a private enterprise (Part III).

CHAPTER II

THE FINANCING OF FOREST ENTERPRISES

Before any profits can be realized on a forestry enterprise, considerable money must be spent on it. Where does the money come from? How are forestry enterprises financed? There are only three ways to get money with which to start a business. It may be saved by those who wish to establish the enterprise, borrowed by them, or obtained on credit, which is only another form of borrowing. When once a business has begun to "make money," some of this profit may be used to expand the enterprise so that it will reap greater profits. Since few persons are able to save enough money to start a business of any size and since expansion of enterprise by reinvesting the owner's earning is generally a slow process, most businesses are started and enlarged by the use of borrowed money.

How much money must be borrowed and how long it will take to pay it back depends on the size and nature of the enterprise. A portable sawmill owner who buys only a small amount of timber which he manufactures and sells immediately may finance the operation on credit from the wholesaler who is willing to pay for the lumber before it is delivered. A company starting in the lumber business must borrow a much larger sum for a longer time because it will be several years before it can sell its product. The borrowing, therefore, will have to be by some other method. An individual wishing to go into forestry by buying a tract of young timber must borrow for a still longer period. Borrowing may also be necessary in public as well as private forestry because neither state nor federal governments receive enough current income from taxes to buy and care for much forest land.

The purpose of this chapter is to discuss briefly the financing of various kinds of forest and forestry enterprises in order to get a birdseye view of the methods and problems involved. In so doing we shall have to postpone many important points for later treatment.

1. THE FINANCING OF FOREST ENTERPRISES[1]

A. Small Industries. They comprise portable sawmills, rural woodworking establishments, and similar enterprises. They seldom own their own lands, usually buying their timber in small quantities as needed. Their equipment is small and comparatively inexpensive. Such financing as their operations require is usually in the form of short-term bank loans to meet payrolls and current expenses, the logs or lumber serving as security for the loan; or by securing credit in the form of advance payments from wholesalers or other purchasers. Sometimes they secure a sort of involuntary credit by deferring payment of their labor and other bills until they have sold their product. They are often part-time enterprises, the owners engaging in farming or contracting so that their financing may not be independent of the owner's other activities.

B. Medium-Sized Industries. They consist largely of sawmills with a capacity of 5 to 20 million bd. ft. a year. Such mills cannot operate without an assured timber supply far enough ahead and large enough to keep them going uninterruptedly for at least five years. This usually involves buying the land on which the timber grows. This fact, plus the need for larger and more elaborate mills and logging railroads, trucks, tractors, etc., demands medium- or long-term financing. The cost of buying timber, erecting mills, constructing logging improvements, even on a relatively small operation, may cost several hundred thousand dollars before a single log is cut. Some of the equipment may be purchased on a basis-allowing payment when the mill begins to operate, but there is a limit to this possibility. Nobody will extend credit, in the ordinary sense of the term for, say, $100,000 for ten years. Therefore, in most cases all or most of the initial cost must be met by borrowing. The common procedure in such situations is for the owner to obtain funds by organizing a company and by selling stock, that is to say, certificates, entitling the purchasers to share in the profits of the enterprise according to the amount of their stock. The company can also issue bonds, that is, long-term loans paying a definite rate of interest. These bonds are usually secured by a mortgage on the property of the company (Chapt. III).

C. Large Enterprises. They include large sawmills and most pulpmills. Their financing differs more in magnitude than in kind from those of medium-sized companies. Where one needs a few thousand dollars, the other may need several millions, and the necessary loans

[1] No attempt is made to discuss secondary forest products industries.

may run from 20 to 50 years instead of from 5 to 20. These large enterprises seldom start as entirely new companies but are outgrowths of those already in the field, although the new ventures are often independently financed. The financial soundness and technical experience of the parent company often make it easier to secure funds for the new venture.

The largest companies are financed from great city banks and other financial institutions, often at a great distance from the operation. Sometimes they are outgrowths of family enterprises and the stock and bonds are closely held; in other cases they are more widely distributed. But the stocks and bonds of such companies are seldom listed on stock exchanges or traded in for investment and speculative purposes by either professional exchange operators or by the general public. Only a few of the largest pulp and paper companies have their securities listed on the large exchanges and as individual corporations enter the realm of "high finance."

2. THE FINANCING OF PRIVATE FORESTRY

It is impossible to discuss in detail the financing of private forestry without some understanding of capital and interest and of other matters treated in succeeding chapters. Hence, only a few introductory ideas are given here. Suffice it to say that all financing of true forestry is of a long-term nature, much longer than for forestry industries. Whether one commences with a forest ready for logging or with a cutover area, the length of the term is dependent upon the length of the rotation necessary to bring the crop to maturity, which may run from 30 to 100 years. However, we shall see immediately that, when forestry is conducted on a small scale as part of a general land-management operation, such as a farm, this long-term financing is a theoretical rather than a practical consideration, and the financing of long-term operations by concerns already in business is not as difficult as it sometimes seems to be (Chapt. XIX).

Since "private forestry" is a very general term, we must break it down into various kinds of private forestry, each of which has its own financial aspects, and discuss them separately. The following classification of forms of private forestry is based largely on its objectives and type of ownership:

A. Farm forestry.
B. Estate forestry.
C. Cooperative forestry.
D. Forestry as a subsidiary enterprise.

E. Industrial forestry.

F. Forestry as an independent enterprise.

A. Farm Forestry. By farm forestry is meant the continuous production of timber crops on the farm, in contrast to the all-too-frequent custom of cutting off a woodlot when it contains merchantable material and when the owner needs money. Despite the great importance of a well-kept woodlot as a source of material and cash, farm forestry does not usually need much long-term financing, except when a farmer may be in debt and therefore tempted to sacrifice his woodlot. At such times a loan would help. But loans on woodlots are hard to get. The woodlot, like other income-producing parts of a farm, is seldom the subject of separate accounting, as it would need to be in forestry operations on a larger scale. Its costs are usually treated as current operating expenses rather than as investment costs.

B. Estate Forestry. By estate forestry is meant forestry practiced by owners of large private estates under a definite policy of improving the forest by silvicultural methods, not a policy of holding it for game or scenic purposes. Such owners may be wealthy individuals or associations. True estate forestry may have the following objectives: (1) the production of timber to pay for or reduce the cost of maintaining the estate as a whole; (2) the improvement of the forest to increase the total sale value of the property. Generally speaking, individuals or associations who can afford to own forested estates are able to do all the necessary financing themselves. Often their operations are too expensive to be justified from a financial viewpoint. However, valuable forest properties have been built up in Europe by this method, from which descendants of the original owners have profited greatly.

C. Cooperative Forestry. The small woodland owner is always at a disadvantage in marketing his products because of the small volume produced by selective cutting on small areas. To overcome this disadvantage such owners may organize a forest cooperative among themselves, pool their cut, engage technical assistance, perhaps even set up their own mill, thus obviating their individually disadvantageous position in dealing with mill men and lumber buyers. Cooperatives, like all other forms of business, require capital. It may be raised among the members or borrowed from private sources or from public agencies. The federal government has lent funds and technical assistance to a number of such groups. Properly organized, financed, and managed, they form an excellent vehicle for the practice of forestry by small owners.

D. Forestry As a Subsidiary Enterprise. Forestry may be practiced as a means of protecting or gaining an added return from land held for some other primary purpose. The commonest example is that of municipal water companies that are obliged to hold large acreages for the protection of their watershed. Their main business is supplying water, but added revenue can be obtained by practicing forestry on the land. The financing of the land is an essential of their main business. The improvements to the forest, chargeable to forestry operations, may be made from the earnings of the main enterprise or by special borrowing according to the financial needs and policies of the company.

E. Industrial Forestry. By this term is meant the practicing of forestry by an individual or by a company engaged primarily in the manufacture and sale of forest products, their object being to insure themselves a continuous supply of raw material to meet all or part of the needs of their manufacturing plant. We are likely to think of this type when we use the term "private forestry." Providing for a continuous supply of raw material for a large sawmill or pulpmill requires a large area of land and a large stock of continuously maturing timber, an investment which necessitates both large and long-term financing. Hence, unless the concern is very prosperous, extensive borrowing is essential. Usually it can be paid back only as the successive crops of timber mature and are turned into money. Once the company is on a productive basis, part of its investment in timber is being turned into money and can pay for more young timber, so that the long-term feature of the investment is not necessarily serious.

Sometimes an industry using timber or other wood products may find it expedient to grow its own supply, as a large coal mine which has constant need of mine props in its operations. Experience may prove that the cheapest way to get such products is to own forested land from which they can be cut as needed. In this event, they may be financed out of profits or as part of the general financing scheme of the company.

F. Forestry As an Independent Business Enterprise. Sometimes individuals, families, or companies engage in the business of growing forest products for sale in the open market, rather than for manufacture into more or less refined products in their own plants. This form differs from both farm and estate forestry in that it is a self-sustaining business, although frequently it grows out of one of these forms. It is rather rare in this country but more common in Europe. Since it does not have to produce a given quantity to supply a mill, it can be built

up more easily from earnings and for that reason may have advantages although, on the other hand, individuals may have more difficulty in borrowing funds than have established businesses with mills and other assets that can be used as securities for loans. Also, all the profit must come from the growing of timber, without the additional profit to be obtained from its manufacture.

3. THE FINANCING OF PUBLIC FORESTRY

It is just as necessary that funds be obtained for the financing and development of public forests as it is for private forests and forest product industries. Since public forest administrations seldom conduct their own logging and milling operations, but usually sell their products on the stump, their financing is concerned with growing rather than with harvesting.

The popular concept that by legislative action government can create funds for all its needs, regardless of the economic and financial principles that apply to private business, is false. Governments have but one ultimate major source of income, that is, taxes, the amount of which depends on the productive wealth of the community. The amount of annual taxes, like the profits of a corporation, may be inadequate to provide for the desirable expansion of its enterprises. Just as a prosperous sawmill company may not have money enough to build an addition to its mill which will enable it to make more money and, therefore, may borrow the funds necessary to finance its new addition, so a government, not having sufficient tax revenue when it needs a new road, may borrow the needed funds. Both may and usually do use the same method, namely, the issuance of bonds. In the private company, the interest and principal of the bonds are expected to be paid off from the earnings of the enterprise; in the government, they are usually paid off from future taxes. The theory is that if bonds are issued the improvement can be obtained at once and paid for over a long period, whereas it would be impossible to raise sufficient taxes in one year to pay for it immediately.

However, certain public improvements, by increasing wealth, make possible larger future taxes than would accrue if the improvement were not made. A new highway usually increases the value of adjoining property; hence, after the road is built, the taxes of those who own property along the road can be raised, and from them the bond issue can be paid in part or as a whole. If a governmental expenditure produces direct revenue, as does a toll bridge, the bonds issued to build it may be paid off from its earnings. The same would apply

to a public forest although the bonds have a very long term and low interest rates. Borrowing by public agencies may be for a specific purpose, as a bond issue to purchase a state park, or for general public improvements. Occasionally they are made for current expenditures although this is generally poor policy except in emergencies such as foreign wars.

Public forestry may be practiced by national, state, or local governments.

A. Federal Government. It is frequently said that the national forests set aside from the public domain, which still constitute the largest area of our national forests, cost the government nothing because the land already belonged to it. This is not strictly true. The land was acquired either through purchases, such as the Alaska and Louisiana purchases, or by conquest. The $7 million that paid for the Louisiana purchase was financed by a federal bond issue paid for over a period of 30 years. Some of the cost of the Mexican war was defrayed by borrowing; probably the Indian wars were paid from income, that is, taxation. The cost per acre of the public domain lands now in the national forests was very small, but the government did not get them for nothing. Since some of the indebtedness of war and other items chargeable to the territorial expansion of the United States are still not completely paid off, we are, in effect, still paying for the original national forests and for a great deal of the present and former public domain.

The national forests of the East, created under the Weeks Law and subsequent legislation, were bought outright from private owners out of annual appropriations made by Congress for the purpose. The national forests purchased previous to 1933 were paid for from taxation, out of current income. Since then, the federal government has resorted, for the first time in its history, to extensive borrowing for peace-time expenditures, and some of its resultant funds have been used for national forest and other types of land purchase for forestry and allied uses. Since, except in special cases, the funds obtained by federal borrowing are used along with tax receipts instead of being allotted to specific projects, it is impossible to tell whether a given project is financed from taxation or borrowing.

Until the time of large-scale borrowing, improvements to the national forests were paid for from annual appropriations made by Congress for the purpose and taken from annual taxes. These appropriations were far below what was necessary to put the forests in good productive condition or even to protect them adequately. It was not

then the policy of the federal government to resort to borrowing for the purpose of either purchasing or developing forests. From 1933 to 1939 large sums of borrowed money went into developing the national forests through the Civilian Conservation Corps and other federal relief organizations (Fig. 47). Probably Congress would never have been willing to make such appropriations except as a means of supplying labor opportunities in a time of financial depression, no matter how badly the forests needed to be increased in area and developed.

B. State Governments. With the exception of states receiving gifts of federal lands for forestry purposes and of those states whose forests have been built up from cutover land reclaimed from delinquent taxpayers, state forests have been purchased from private owners. Sometimes these purchases have been financed on an annual or biennial basis from tax receipts. The state legislatures make the appropriations, the size of which depends upon (1) the financial condition of the state at the time; (2) the relative strength of public interest in state forests as compared with other public improvements. When public interest in forest land acquisition rises high enough so that it is not satisfied with the progress that can be made by purchasing with relatively small sums from tax receipts, bond issues are used. Sometimes they are general bond issues, a portion of which has been allocated to land purchase; sometimes they are special issues for forest land or for forest and park land only. Gifts from private citizens have paid for considerable areas of state park and forest land.

Financially speaking, land gifts from the federal government to states may be considered a form of intergovernmental subsidy (Sec 5) and, like private gifts and tax-delinquent land, may be set down on the state books at whatever administrative costs were involved in taking over the land. However, where tax-delinquent lands are concerned, the states do not gain financially by the transaction because, before they were stripped of their timber, the lands were a taxable asset. By allowing the owners to ruin them so that they are not worth paying taxes on, the state has lost a financial asset, to say nothing of the indirect financial and social loss which always accompanies the destruction of a natural resource.

The cost of development of state forests, like that of their acquisition, has come, until recent years, from appropriations and bond issues, much more largely from the former. In general, funds for this purpose are appropriated even more grudgingly by state legislatures than by Congress for the national forests. State forest administrations often have barely the minimum funds necessary for fire protection. In some states they are able to utilize funds from timber sales on state forests

for improvements but, as most of the forests are located on cutover or devastated land, the process of building up the necessary improvements is almost infinitesimal. It is like building a portable sawmill operation into a great pulpmill entirely by reinvesting earnings, a matter of many years, and seldom possible even then.

State governments sometimes use special taxes to support certain aspects of their forestry programs. The State of Maine assesses a special tax on timber land acreage in the northern part of the state for fire protection, and Arkansas levies a severance tax on all timber cut in the state, the proceeds of which are used for upkeep of the forestry department.

C. Local Governments. Counties, cities, and towns are more likely to own parks than forests. However, all frequently operate public water supply systems which require considerable investments in forest land. To buy, protect, and develop these lands bonds are frequently issued, and sometimes special assessments or taxes are levied. With water supply forests, the cost of land, dams, reforestation, and the like can be recovered from charges for the use of water and, in the long run, income from the forests may also be used for this purpose. With parks, this is not possible. Expenditures for parks belong in the category of public activities, intended to yield an indirect social benefit not comparable to a public business enterprise, such as a forest or waterworks. Usually any attempt to pass the entire cost of a park on to the users would defeat its social end by making charges so high that the members of the public needing it most could not afford to use it. This does not mean that small admissions or charges for special services cannot be assessed which are not a burden on the users and will meet all or part of the operating costs. The initial cost of land and improvement, in nearly all cases, must be paid for from tax revenues.

4. PUBLIC FINANCIAL ASSISTANCE TO PRIVATE FORESTRY

Nearly all governments extend both direct and indirect assistance to private industry of all kinds. This takes various forms, such as rebates or reductions on taxes, loans at low rates of interest, import duties or tariffs to prevent or discourage importation of competing foreign goods that might reduce the market for domestic products, subsidies [1] direct or indirect, use of the general police power to protect life and property.

[1] A subsidy is a sum of money used by a government or political unit to assist a private individual, a business, and, occasionally, another governmental unit. It may be assigned directly and then is known as a *direct subsidy,* or given indirectly and known as an *indirect subsidy.*

The federal government and many of the states give indirect assistance to forest owners and to those wishing to practice forestry on their land; a small amount is sometimes given by local governments. The first two have, and are extending an enormous indirect subsidy to private owners through their forest research and extension work. They have developed a vast body of technical information about forestry practices and the use of forest products. This information is available to all types of owners and for all kinds of forests. It could never have been collected for the country at large by private agencies.

Likewise the states, by organizing fire-protection agencies with the necessary legal and police powers and appropriations for fire suppression on private land, have in some places taken over all direct costs of suppression and in others have given private owners great assistance. The federal government indirectly assists in this action through grants to the states for part of the costs of fire protection. The sale of forestry nursery stock at cost of production or at very low prices is another form of public aid to private forestry. They are all indirect public subsidies to private forestry. Sometimes their significance is underestimated in an argument that governments, by their programs of public forest acquisition, are competing with private industry. The federal government has also assisted the states in their forestry programs, and some of the assistance which it renders to individuals comes to them through the intermediary of state forestry departments.

CHAPTER III

BUSINESS AND FINANCIAL ORGANIZATION

Business as a whole may be visualized as the enterprise of turning natural resources into forms suitable for the satisfaction of human needs. The agents of the transformation are two: (1) the mental and physical labor of human beings and (2) their accumulated savings called *capital* (Chapt. IV). The ultimate incentive is profit to the owners. Many businesses, of course, are but secondary agencies in the process. They pass the finished products to the consumer or operate the various service businesses which apparently are in no way concerned with natural resources, but which can easily be traced back to them. Does not a summer hotel make forest scenery, which is a natural resource, available to the dowager in the rocking chair on the front porch?

A distinction can be drawn, if desired, between private business—where the monetary profit motive to owners is and must be paramount—and public businesses—operated by the state under the control, immediate or remote, of the citizens who make it up and to whom the profit is distributed in the form of service which varies from free education to military protection. The service performed by public forestry is well known.

In this chapter business and financial organization, both public and private, is analyzed, the better to understand those aspects of the forestry profession.

1. CLASSIFICATION OF PRIVATE BUSINESSES

The following classification includes only the businesses discussed in this text:

Those providing services rather than goods.
Those producing raw materials.
Those extracting raw materials.
Those manufacturing finished products from raw materials.
Those collecting, distributing, and selling materials to consumers.

Businesses that provide services include several groups. Among them are the transportation and communications group, comprising steamships and telephone and telegraph lines. Another group includes specialized and professional businesses, such as insurance companies, law and architectural firms, firms of consulting foresters who estimate timber and advise their clients as to methods of handling their forests.

By businesses that produce raw materials,[1] are meant those actually creating, *not* just harvesting or extracting them. The growing of crops, whether farm or forest, is the chief example of businesses that produce raw materials. Strictly speaking, the lumberman is *not* producing timber, only harvesting or mining it, unless he is also in the business of growing it. Among the businesses that extract raw materials are mining, quarrying, commercial fishing, and lumbering. Such businesses may operate on either natural or man-produced supplies, provided in the latter example that man is able to create the materials in question. These industries are sometimes called the *extractive* industries.

When first extracted or produced, raw materials are seldom of much use to the ultimate consumer. The housewife wants a loaf of bread, not a bushel of wheat; hence the wheat mill. The building contractor wants structural-steel beams for his skyscraper, not iron ore; matched oak flooring, not a pile of oak logs. Hence the vast and varied manufacturing industries which loom so large in our civilization, all utterly dependent upon the production or extraction of raw materials for their existence.

The collection and selling of materials to the consumer include the familiar fields of wholesale and retail business and, in addition, the collection and sale of raw materials to manufacturers. This is often called *jobbing*. A man who makes a business of purchasing pulpwood from farmers—buying a few cords from one man, a few from another, and so on—who collects it and ships it in quantities to a pulpmill, is called a *jobber*.[2]

One organization may engage in several or even all of these lines of business, and there is, in actual practice, a good deal of such combination. In the field of forest enterprises, a company may operate as consulting foresters and at the same time own lands, grow timber on

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[1] By raw materials are meant the basic supplies necessary for life and civilization, such as ores, timber, food supplies. Food supplies are sometimes treated separately, but here it is better to think of them as raw materials.

[2] The term *jobber* is often used in the forest industries as the equivalent of *contractor*, as one who cuts logs on a contract basis.

them and log it, and operate a sawmill and planing mill and sell its lumber through its own retail yards as well as through wholesale dealers. Such a concern would be known in business parlance as a *vertical* organization. That is to say, it engages in all steps of the process of production and distribution, from production of raw materials to distribution through its own sales outlet to the ultimate consumer. A *horizontal* organization, to use the companion term, would be a concern operating a string of sawmills in different parts of the country in different species—a company, say, which had a yellow pine mill in the South and a Douglas fir mill in the Pacific Northwest, or a company owning a string of mills in one region.

The theoretical advantages of the vertical arrangement of various businesses dealing in the same raw materials are, first, that the concern so organized controls its own raw materials, and hence is not subject to having them cut off entirely or the price raised unreasonably by competition; second, that by having its own sales outlets it retains the profits which wholesale and retail dealers would have to make if they sold the materials. These advantages can be realized only if the management of the concern is sufficiently competent to keep costs of operations and raw material lower than purchase prices and to operate its sales agencies as cheaply as could wholesale and retail dealers. Neither of these things is always easy. A theoretical disadvantage is that the concern so organized involves much larger financing, the cost of which may be greater than the other savings. The theoretical advantages of a horizontal organization are that by producing a large volume or more diversified products the concern is in a position to increase its volume of profit. However, the larger it becomes—unless it controls a very large supply of raw material—the more vulnerable it becomes in the face of a shortage or of high prices.

Businesses engaged in more than one line, whether in the vertical or horizontal form, or even in a simple form, may be organized into a line of companies under the same ownership and control. Thus we might have a group of companies centering around the manufacture of paper pulp, all operated as one business unit as follows: The Blankville Forestry Company owns the land and grows the timber, the Blankville Logging Company does the logging, the Blankville and Xtown Railroad transports the wood, the Blankville Pulp and Paper Company does the manufacturing, the Blankville Sales Company handles the sales, and the Xtown Electric Company supplies the power. Further companies, such as a commissary company to supply camps, a real estate company to purchase land, might make up the full ac-

tivity of the business. There are many arguments pro and con as to the managerial and financial advantages of multiple-company as compared with the single-company form.

2. LEGAL FORM OF BUSINESS ORGANIZATION

A business may be set up in any one of four legal forms: (1) the personal form, where it is owned by a single individual; (2) the partnership form, where two or more persons enter into legal relationship to conduct a business jointly with a definite understanding as to their mutual duties and obligations, distribution of profits, etc.; and (3) the corporate form, where ownership belongs to a group of persons, each of whom has invested in it by the purchase of stock. Such concerns have to be organized under laws which specify the conditions under which they may operate. (4) The cooperative, where a group of independent producers join together to buy raw materials and supplies or to sell their own products.

Individually owned businesses are apt to be small and to suffer from the difficulty that a single individual has in borrowing large amounts of capital in his own name, particularly if it is desired for a long term. Likewise, on the death of the owner, the business must be divided, in America, among his heirs; this division often results in the breaking up of the business. A man might own, for instance, a small sawmill and a forest which would keep it going indefinitely or a private estate upon which he had been practicing forestry for many years. On his death, if his heirs were not interested in making some arrangement by which the work would be continued, the property might be sold into less interested hands or divided between the heirs, each of whom would get too small a portion to permit economic operations on a forestry basis. In England, where the law provides that all property must go to the eldest male heir and, in France, where there is a strong feeling for the continuity of family enterprises, the chances of forest properties being held together and managed for continuous production, is greater than in America.

Private business, however, may be incorporated and the owner retain practically complete ownership, only enough stock being issued to others to satisfy legal requirements, and this may be held by members of his family or trusted employees. It is probable that by use of this small, closely held type of corporation, plus the use of trust agreements, a family forest property could best be held together in America.

Partnership businesses are less common than they were formerly and have few, if any, advantages under ordinary circumstances over

corporations, as a vehicle for transacting business. Cooperatives are discussed in Section 4, corporations in Section 3.

3. NATURE OF A CORPORATION

Since most businesses are conducted as corporations and it is difficult to conceive of private forestry as a long-term business being conducted on a large scale in any other way, it is necessary to discuss the legal and financial nature of a corporation in some detail.

A. Stock and Stockholders. The persons who provide the money or other property necessary to organize a company are called its *original stockholders* (or shareholders). They are also its original owners. Their ownership is attested on certificates which state how many shares they own. These shares may be bought and sold, and then the seller gives up his ownership and the purchaser acquires it. The extent of ownership is determined by the number of shares a person owns. If there are 1000 shares outstanding and one man owns 950 of them, he is essentially the owner of the corporation. If each of three men owns one-third of the stock, ownership is shared equally between them because each share of stock entitles the owner to one vote. In huge corporations where there are many thousands of shareholders, the proportion of ownership of any one individual is extremely small.

B. Control of Corporation. Each shareholder is usually entitled to one vote per share in the management of the company. (There are types of stock which do not carry voting rights, but they are unimportant in this connection.) Thus control of a corporation, as well as ownership, usually lies in the hands of a few of the stockholders whose holdings are the largest. In the largest corporations, ownership is often so widely dispersed that not only is the individual control of the average owner nil, but even large holders of stock can exercise little, if any, effectual control since they are profit sharers rather than owners. Control really lies in the higher salaried personnel and the banking interests which represent the bondholders (Sec. 4*B*). But in small, closely held corporations, this control of the stockholders is real if they care to exercise it by attending meetings and voting intelligently on its affairs.

A company, by vote of its stockholders, can increase the amount of its stock in order to finance its growth. The original stockholders, usually voting themselves, purchase rights first and only offer the stock to others after they have purchased as much as they desire or can afford.

When stockholders sell their stock in whole or in part, the price may be greater or less than that paid into the company in the first place, but the company neither gains nor loses by this change of price. Stock is usually issued with a definite value per share, often $100. Whatever this value may be, it is known as *par value*. The stock may actually sell at more or less than this sum, depending upon the financial condition of the company and the general business conditions at the time.

The stockholders elect the board of directors and other officers of the company who are usually the real governing body in the average corporation. The larger corporations, as stated above, are run, except in the most important matters, by the higher salaried personnel.

Annually, or at shorter periods, the stockholders or the board of directors vote upon the disposition of the profits of the company. They may vote to pay all, part, or none of them to the stockholders. Whatever portion is paid to the stockholders is in proportion to the number of shares each holds at the rate of so much money per share—usually expressed in terms of percentage. This payment is called a *dividend*. Thus if the profits of the company justify a payment of $8.00 per share on shares of $100 par value, the company is said to have paid an 8 percent dividend.

That portion of the annual profits not distributed to the stockholders may be (1) set aside as a reserve against future years when profits may be less or even non-existent, (2) used to pay off bonded or other indebtedness before it is due and thus save interest, or (3) used to expand the activities of the company, as by buying more timber or a more efficient mill, and thus may avoid borrowing money to make these changes. This last method expands the size of the business and hence, in theory, its profits.

A conservatively managed company, therefore, will not pay out its entire earnings annually but will set up a reserve for contingencies, debt retirement, and expansion (Chapt. VII, Secs. 5 and 6). If the officials of a lumber company, for example, were convinced that it was good business to go on a sustained yield basis, but did not have land enough to do so, they could purchase young timber lands each year from part of the company's earnings and thus gradually work toward this objective.

However, in small companies where the stock is closely held and the stockholders exercise real control unless they are convinced of the desirability of foregoing a present for a larger future profit, they will vote against such a policy. There are examples where stockholders,

consisting largely of elderly people, have refused to permit the management of a lumber company to go on a sustained-yield basis. On the other hand, the stockholders in a large corporation, if scattered and unknown to each other and unable to attend meetings, might not be able to force the management of a company to practice forestry even if almost all of them were convinced of its desirability.

It is necessary to remember, however, regarding the profits to stockholders, that, when the company loses instead of makes money over a term of years, not only are there no dividends but also the value of the shares deteriorates and will finally approach zero. If the company goes out of business while still solvent, proceeds from the sale of its assets will be divided among the stockholders in proportion to the amount of their holdings and may be more or less than the total par value of its stock.

C. Organization of a New Company. The money of the original stockholders of a corporation is supposed to be used to acquire its first assets, pay its first wages, and meet other initial expenses until receipts begin to come in.

Let us suppose, for example, that a new company has been organized to log and saw a 10,000-acre tract, the estimated costs of initial operations being

Land and timber	$300,000
Logging and railroad equipment, etc.	100,000
Mill	75,000
Total	$475,000

Presumably they would have sold $500,000 worth of stock, with the idea that the remaining $25,000, working capital (Chapt. IV, Sec. 2), would carry their cutting and milling costs until enough lumber could be sold to meet running expenses.

Perhaps it later develops that the remaining $25,000 is not enough to conduct operations till money begins to come in, and more must be borrowed. If the additional sum required is small, it can be raised perhaps by credit from a wholesaler who may pay for the lumber in advance of receipt or by a short-term loan from a bank on some sort of security. If a large additional sum is required, the above borrowing methods may not be possible. In that event the company has the alternatives of selling more stock or of making a long-term loan, usually in the form of a bond issue secured by a mortgage on the property. In the first alternative, the size of the company is increased by the original owners or by the addition of new owners and more

capital. In the second, the company goes into debt and, because of mortgages, may lose a measure of control over its affairs.

4. FORMS OF LOANS

In the above section several different forms of loans were discussed without being defined. They will now be treated in detail.

A. Short- and Long-Term Loans. As one might guess, a short-term loan is one made for a short period—from a few days to several months; such loans are for the purpose of tiding the business man over temporary difficulties, as waiting for a customer to pay for ten carloads of lumber. The loans usually are made from banks and may be on a discount or straight-interest basis. Sometimes they are made without "security"—in other words, on faith that the lender will get back his money. At other times the goods which the company has not yet sold are pledged to the bank or to the individual making the loan. He loses the goods if he fails to pay. Short-term loans play a large part in ordinary business affairs but little in financing.

Long-term loans run for many years and are usually on some definite security. The common forms of such loans are mortgages and bonds. Although different in form, they are closely interrelated.

B. Mortgages. A mortgage is a loan made upon the security of a piece of *real estate*, that is, land and building, belonging to the borrower, in which he agrees to pay a fixed rate of interest annually upon the loan until it is repaid or, in the event of non-payment, to forfeit all or such part of the property as is necessary to pay the loan plus accrued interest. Mortgages are usually recorded with the proper public officials as a protection to the lender. A mortgage may or may not require that the lender pay back part of the loan at regular intervals. Sometimes a second loan of the same nature is made on the same property by another lender and is known as a *second mortgage*. If the borrower fails to pay and his property is foreclosed by the lenders, the one holding the first mortgage is entitled to be paid first. If the property has depreciated severely in value, neither may get all his money back and perhaps the one holding the second mortgage will get nothing.

C. Bonds. A bond is a form of long-term loan, for a definite number of years, at a definite rate of interest which must be paid at specified times, usually semi-annually. Bonds usually are secured by mortgage on the company's property or by other definite provisions under which, if the interest or principal is not paid when due, the bondhold-

ers, acting jointly, may take possession of the property or business. Bonds, like stocks, have a definite par value; also like them, they may sell above or below that value, depending upon the financial conditions and prospects of the company and general financial conditions at a given time. Their par values are usually $500, $1000, and multiples of $1000. Unlike stock which bears no definite term of life, bonds are issued for a term of years, usually from 10 to 50. The corporation issuing them must be prepared to pay them back at the end of the time for which they are issued, although it is often possible, if they are a good investment risk, to extend their life if the company still needs the money. Bondholders are not part owners of a corporation but lenders to it.

Bonds are not issued directly by a company to individual holders but through the services of a bank or other financial institution, which underwrites the whole issue, provides the funds for the company and sells the bonds to investors, charging a commission for so doing. The mortgage, or other security for the loan, usually resides in a trustee who is supposed to represent the interests of all bondholders. The financial institution issuing the bonds and the trustee can bring more or less pressure to bear on the managers of the company, first, by stating the terms under which they will issue the bonds; second, by exerting pressure if the affairs of the company indicate that interest may not be paid.

Bonds are classified in various ways: one is according to how they are secured, for example, the manner in which the owners may recover their investment should the company *default,* that is, fail to pay the interest or the principal sum when due.

The safest type is a *first-mortgage* bond, secured on the entire property of the company or a sufficient portion of it to cover the value and interest on the bonds. *Second-mortgage* bonds are less safe because, should the company default, they cannot be paid until all the claims of the holders of first-mortgage bonds are satisfied. *Debenture* bonds are not based on a mortgage on the company's property, but the trust agreement usually is that the interest and principal are a first obligation on the earnings of the company. In other words, the stockholders cannot vote themselves dividends, set aside reserves, or otherwise spend money until they have paid the bond interest. Another form of protection afforded investors in debenture bonds which may be incorporated in the trust agreement is an understanding of how the business shall be conducted. Such agreements may be to the advantage of the bondholders but may also operate to prevent expansion of the

business. Mortgage bonds, in general, are a safer form than debenture bonds. The latter are seldom issued unless the company already has mortgage bonds or other loans covering the value of its property.

Two special kinds of bonds of the mortgage type, of interest in the financing of forest enterprises, are timber bonds and equipment bonds. *Timber* bonds are a form of bond used in financing lumber operations. They are ordinarily secured by a mortgage on the land and timber and by a requirement providing that a stipulated amount be deposited in the sinking fund for each thousand feet of logs or lumber cut.[1] They are usually issued by financial institutions that have special interests in the forest industries.

Equipment bonds are issued to cover the cost of major equipment. They are based on a mortgage held by the seller, usually the manufacturer, and secured by the equipment with the stipulation of a definite rate of payment. They may be used by lumber and pulp companies to obtain their equipment.

A third type of bond which, in theory, should meet the needs of a deferred payment investment such as forestry must usually be in its initial stages (Chapt. VI). They are known as *discount* or *appreciation* bonds. Such bonds pay no interest until they are mature, when they pay it all as a lump sum together with the original principal. If they are a good risk, they appreciate in value as maturity approaches; and the investor who cannot afford to wait for his return until the bonds are mature usually can sell them at any time and realize his interest to the time of sale by this increase in value. A 10-year discount bond, having a maturity value of $1000, if issued at $750, would increase in value at an average rate of $25 per year. The best known form of discount bonds are those issued by the United States Treasury Department, formerly called United States savings bonds, now referred to as defense or more recently as war bonds. While theoretically, as stated above, bonds of this type should meet the needs of those desiring to start forestry enterprises, it is doubtful if under present conditions they could be sold to investors for that purpose. Public bonds differ in some respects from private bonds, as discussed in Section 8*C*.

However long bonds may run, if 5 or 50 years, or even if they are reissued when due, they must be paid eventually out of the earnings

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[1] Good references to timber bonds are T. S. McGrath, *Timber Bonds*, Craig-Wayne Company, Chicago, 1911; and *Timber Bonds As Investment Securities*, Supplement to American Academy of Political and Social Sciences, Philadelphia, May, 1912.

of the company.[1] It is scarcely to be expected that the average company will make profit enough in any one year to do this. Consequently, each year a sum should be set aside for this purpose. It goes into a so-called *sinking fund*, which either accumulates until the bonds are due or a portion is used each year to buy back part of the bonds (Chapt. VII, Sec. 6). Of course, with bonds issued in order to finance additions to the company's property which will not yield a return for many years, a sinking fund can be set up only if the earnings from other sources are sufficient. Let us suppose, for example, that a turpentine company had issued bonds for the purchase of a tract of young timber which will not be ready to work for ten years. If its earnings from the timber which it is operating in the meantime are sufficient, it could start setting aside a sum each year to pay off these bonds. If not, all it could do would be to meet the interest as it came due and start to pay off (the word "retire" is often used in place of "pay off") these bonds when operations start in the young timber.

D. Use of Bonds and Other Long-Term Loans. In the discussion of the organization of a lumber company (Sec. 3*C*), it was assumed that all the initial financing was from the sale of stock. This is not always possible. Too few people with money to invest care to risk it in an entirely new venture even if, as is not always true, there is money enough available in the community. Perhaps, therefore, the group of lumbermen who organized the company can sell only $90,000 worth of stock to others and have for themselves $110,000 of their own money which they exchange for stock. This gives them control of the new company, but they are still $300,000 short of the half million which they estimated as necessary. What to do? Perhaps the owner of the tract will take a mortgage for $200,000. If not, perhaps a bank will float an issue of timber bonds for that or some other portion of the purchase price of the timber tract. One possible way of getting the money for the logging railroad would be to incorporate it as a separate company with the same stockholders as the lumber company and the same officers, each stockholder agreeing to pay into the railroad company a certain amount for the stock at a future date. This stock could be trusteed to a bank as security for a loan with which to build the railroad. Observe that, if the owners fail to pay for the stock, the bank becomes the owner of the railroad. A loan in the form of equipment bonds might be made to the company by a company dealing in logging machinery; and, finally, a company specializing in the con-

[1] Occasionally *perpetual* bonds are issued which are not expected ever to be paid off.

struction of sawmills might agree to build the mill with the understanding that it would receive payment over a series of years after operations started, protecting its interests by a mortgage on the mill, the value of which would be decreased annually by a partial payment plus interest on the sum remaining unpaid.

Supposing all this has been the transaction, the following points are illustrated: The company is in debt for 60 percent of its initial investment before it even cuts a stick of timber, it must pay interest on all these debts before it can show a profit to its owners. If it fails to meet the interest on this debt, the owners will lose control of the business to the various creditors, who, acting in concert, as they thought most likely to be to their best financial advantage, might take the business over and operate it, close it out and sell it, or hire the former owners to operate it.

The ability of a small group of men to secure $400,000 worth of cash and credit with a personal investment of only $110,000 would depend upon the extent of their demonstrated ability to handle the technical details of a business of this type, upon their previous record for integrity, and upon the basic soundness of the proposition from a business point of view. This point involves answers to such questions as: Is the timber cruise accurate? Is the timber worth the price asked? Can it be exploited at a cost low enough to yield a satisfactory profit? Is there a good market for it? Are there sufficient people, financial institutions, and business firms able and willing to lend the money if the answers are favorable to all the other questions?

Once a concern is established and making money, it is usually easier to secure funds to increase the scope of its business than if it were a new enterprise, even in a well-established line; the interest charged for loans is likely to be lower and the stipulations attached to them much less severe. For instance, if the concern mentioned above, after being in profitable operation for several years, wished to borrow money to add to its timber holdings or increase the size of its mill, it could probably do so on much more advantageous terms than stipulated for its initial loans.

Let us suppose, however, that a company which was organized originally only to manufacture lumber decided that forestry was a good thing and desired to go on a sustained-yield basis. Let us assume that the best way in which to do this in this instance would be to purchase tracts of young timber, maturing in 10 to 30 years. Since the company can realize nothing on these tracts until they are mature, it must meet the interest charges on the money to buy them from other earn-

ings. Before it could borrow the money to buy the young timber, it would have to convince the lender that it had enough current income.

5. COOPERATIVE BUSINESSES

Cooperatives may be organized by groups of producers of a commodity for the purpose of marketing it more efficiently or by consumers for the purposes of buying more advantageously. The first are called *producer* cooperatives, the second *consumer* cooperatives. Cooperatives, like corporations, must have capital and issue stock, but each stockholder has only one vote, regardless of the amount of stock he owns. Except for a percentage of receipts which the cooperative keeps for its operating expenses, the proceeds are distributed to the members in proportion to the amount of business they do with it. Thus in a producers' cooperative the more a member sells through it, the larger his profits. In a consumers' cooperative the more he buys, the more the price of each purchase is reduced. Large producer cooperatives may operate factories to manufacture finished products from the raw materials which the members produce, as cooperative flour mills, frequent in the West. Large consumer cooperatives sometimes operate factories to produce goods to be sold to their members. Occasionally, a cooperative is organized both to sell its members' products and to buy their supplies, and producer and consumer cooperatives often have close business connections.

Cooperatives generally are not so large as corporations, but they seem to be gaining in numbers and strength in America. In Europe they are much more important, and some of them rival the great corporations in size. Reference was made to cooperative forestry, which is becoming increasingly important, in Chapter II, Section 2*C*. It will be discussed more fully in Chapter XIX, Section 7.

6. TIME ELEMENT IN BUSINESS

Everything in the business world is based on the making of an expenditure today with the expectation of a profit at a later date. A consulting forester travels from New York to Savannah to interview the manager of a pulpmill, with the hope of interesting him in a contract to survey its property to determine the financial possibility of going on a sustained-yield basis. He knows that if he interests him, the manager must put the question before the board of directors, which does not meet for a month. If the directors are favorable, he knows that it will take a year or more to work up the report and that he will

have to hire several foresters and other assistants to do the work, who will have to be paid regularly, but that he will not be paid until his report is delivered. Therefore, he can figure that it will be 18 months or longer before he gets back the price of his ticket to and from Savannah—if he gets it at all.

The lapse of time between the initial expenditures and the obtaining of a profit, in all except the smallest forest enterprises, is long—longer than in most other businesses. In forestry itself it is longer still, often longer than any other customary form of business in which men engage.

A portable sawmill can be set up—the logs cut, skidded to the mill, run through the saw and the timber sold green—all, perhaps, in a month; and the owner begin to receive a profit, perhaps even close the whole operation. The cycle of operations in a turpentine outfit is several months, but usually a large timber tract cannot be assembled, a big band mill built, roads constructed, and operations started in less than several years. Even if initial operations show an operating profit,[1] the full profit cannot be obtained on all the money expended in purchasing timber land, setting up the mill, and running the operation, until the last log has been sawed and sold—many years after the initial investment was made.

Even in current operations much money is tied up in the unfinished product. A railroad or tractor operation may be able to convert standing trees into finished, kiln-dried lumber in a month and, if business is good, sell it the day it leaves the dry kiln; but in a river-driving operation many months must elapse before the logs even reach the mill, and all the costs of delivering them have to be paid first. If the money is borrowed to cover these costs, interest must be paid on it. If the lumber is sold in advance for future delivery, the price is usually less than for immediate delivery.

When we get into the field of forestry, that is, the growing of wood crops, we are dealing with still longer terms. Suppose a forest is to be created by planting on bare land. Obviously no return can be expected until the first plantations are mature, 30 years at a minimum, 60 or more for slow-growing species. No private business could be started without the expectation of any returns for three decades.[2] Such an operation, if carried on with private capital, would be owned by wealthy individuals, interested in building up a producing property

[1] A profit on actual working operations without reference to interest charges, overhead costs, etc.

[2] In public business this is not necessarily true.

for their heirs rather than in organizing a business. This statement is in no sense to be interpreted as meaning that private forestry is not a possible business field; it is merely to emphasize that starting entirely with bare land it is not likely to be. Private forestry as a business enterprise is considered in Chapter XIX.

7. BUSINESS RISKS

Business not only has to pay most of its bills in advance but also has to take the risk that some or all of its expenditures will fail to yield a profit, that it will suffer losses from the declining prices of the things it sells and from the increasing prices of what it buys, from labor disturbances, and from natural hazards such as fires. The degree of these risks varies with different businesses. Generally speaking, the higher the risk, the more difficult it is to get men to engage in or invest their money in the enterprise.

Forest products enterprises, whether they center around extraction, manufacture, or growing, are among the more hazardous types of business. The reasons are apparent. Logging involves hazards due to fire, floods, and extreme climatic conditions; and milling hazards are probably higher than the industrial average. The use of forest products of all kinds probably fluctuates more than many other commodities with general business conditions.

In forestry itself the long-term aspects create a hazard of their own. Who knows what the selling price of yellow pine common or kraft paper will be in 1980? Again it is repeated that this is intended not to mean that the growing of forest crops is necessarily an unprofitable business but simply to point out an element in this business which is of interest to investors. It will be referred to again in its various aspects in succeeding chapters.

8. THE ORGANIZATION OF PUBLIC BUSINESS

Public business may be defined as "the various activities carried on by governmental agencies, intended to promote the public welfare, irrespective of whether or not they are expected to return a financial profit to the public treasury." Let us now consider how this public business is carried on with particular relation to forestry.

A. The Raising and Expenditure of Public Funds. The basis of public finance lies in the funds (1) raised from taxes, (2) borrowed, to be paid for later out of taxes, or (3) obtained from the sale of goods or services in such incidental or direct business enterprises as the

government may engage. These last are a minor source of revenue in democratic governments. In socialistic or communistic governments they are, in theory at least, the chief or perhaps the only source of public revenue. The power to assess and collect taxes and to borrow money for public uses from private or other public sources lies in the legislative bodies of all democratic governments.

The legislative or administrative bodies assign a portion of the public revenues to various public departments for their needs. These assignments are usually for one year, although where the legislative bodies meet biannually or triannually, they are for 2- or 3-year periods. In making these appropriations, the legislatures are influenced by the apparent need of the several public bodies for funds, by the total sum available from taxes and other sources, and by purely political considerations which may outweigh, in some instances, the other factors. The need for funds for a particular public service is brought to light by the way in which the public supports them. The extent of generosity in which legislative bodies can indulge is limited by the total taxable wealth, and hence by the taxing and borrowing power of the political unit in question, and also by the willingness of the public to support large public expenditures through high taxation and large borrowings.

A state might have large areas of deforested land which could be restored to productivity only if made into state forests, planted, and given other necessary forestry treatment. If it was sufficiently wealthy so that it could convert the land into state forests either directly through taxation or indirectly through borrowing, the only questions would be whether the public was convinced of the desirability and was willing to pay the costs out of the public treasury. If it was a very poor state, perhaps it could not afford to do so, even if its citizens so desired.

Customarily, each public department submits to the legislative body, or to a finance board responsible to it—a request for funds for the next fiscal period. This is called a *budget estimate.* It may be in considerable detail or in general terms. A state forestry department budget, for example, might ask for, say, $250,000 in a lump sum or divided into items somewhat as follows:

1. General overhead, administrative expenses, salaries of higher officials, office expenses, etc.
2. Forest fire suppression.
3. Acquisition of state forest land.
4. Administration and protection of existing state forests.

5. Public education in forestry, such as lectures to school children and technical advice to forest landowners
6. Administration of state forest tree nursery.

If the department is set up so that it can charge for certain services or sell materials, its budget will show its estimated receipts from these sources, as:

1. Sale of forest products from state forests.
2. Sale of nursery stock from state nursery.
3. Rental of camp sites on state forests.

The legislature may grant the total sum requested or may reduce it, either simply by lowering the grand total or by lowering or cutting out certain specific items, as, say, of funds for purchase of more state forests. Sometimes public interest is great enough so that a sum larger than that asked is granted.

In any event some notice is taken of the expected receipts in the general accounting system of the state. There are two general systems of handling them. They may become the property of the department, to be expended for expansion of its activities, or they may go into the state treasury and become part of the general receipts of the state. They are then of no direct use to the department where they originate, except perhaps as they serve as a lever in securing larger appropriations at a later period. Where they may be expended by the department, its discretion may be limited as to how it may spend them. For example, all receipts from timber sales might be required by law to be expended for improvements on the forest or used for the purchase of new forest land.

Ordinarily, a department is required to live within its appropriation. However, owing to emergencies of public business, this is not always possible. A series of disastrous forest fires, resulting from unusual weather conditions in a certain year, may entirely exhaust the forest fire control budget before the fire season is half over. There is usually provision in the fiscal set-up of the state to take care of situations of this kind so that essential services need not be reduced to a standstill. At a later session of the legislative body, a so-called *deficiency appropriation* is made to cover these overexpenditures.

If for some reason not all the appropriation is expended, it may carry over to the following fiscal period or revert to the general treasury, according to how the appropriation is made in the first instance. In some states the governor or an administrative council has

power to reduce appropriations if, in their opinion, the finances of the state are in bad condition.

State forest and park departments which are engaged in buying and selling or in making expenditures, with the expectation of a direct and more or less immediate return, often have so-called *rotating* or *revolving funds.* This involves the granting to the department concerned of a certain sum out of which it makes the expenditure and into which it pays the receipts. At the end of the fiscal period the net gain passes to the general public treasury or may be used to expand the scope of the department's activities, but the original fund remains always with the department. A state forestry department might use such a fund to operate a forest-tree nursery, selling the seedlings to the public, or to make improvement cuttings on the state forests and selling the fuel wood so obtained. They are also used by park commissions to purchase supplies, such as soft drinks, tobacco, and food, which they expect to sell at refreshment booths. Such sales sometimes are made through so-called *concessions,* under which a private agency receives the right to make sales, paying rent on the buildings used and a percentage of profits to the commission. Under such concessions, the prices charged and the types of goods and service sold are usually regulated by the public authorities. There is a great difference of opinion as to the public advantages of concessions as compared with direct sales.

B. Public Business Operated for a Profit. Public business, such as municipal water or power plants, which are intended to be entirely self-supporting and capable of yielding a financial profit on their operations, may not be obliged to call for appropriations at all. Moreover, under the laws which create them, they sometimes have almost complete fiscal independence to invest their profits in increasing the efficiency of their plants and to issue bonds in their own name if necessary to provide for growth. It is usually considered better public policy for them to reduce their rates to the public than to pile up a large surplus of funds. Sometimes they are expected to lighten the general tax load of the community by paying their profits into the general treasury.

C. Public Bonds. Legislative and, sometimes, administrative bodies have the power to issue bonds. Occasionally, their issue has to be approved by popular vote. Bonds of public agencies have points of similarity to and difference from those of private corporations. Seldom are they secured by mortgages on public property and, only in special cases (discussed below), by provision similar to private deben-

ture bonds. No trustee could take possession in the name of the bondholders of a post office or a national forest if the United States government should default on its bonds. Nor is any obligation entered into with the bondholders to conduct national affairs in a way to satisfy them, although investors can refrain, of course, from buying these bonds if they are not satisfied that the credit of the government is sound or if they do not approve of its policies. Usually the federal government issues its own bonds, which are sold largely to banks that may use them as part of the financial reserve which they are legally obliged to carry.[1] Occasionally the government sells bonds directly to the public, as it sold bonds during the first World War and is now doing in the second one. In recent years the federal government has made much use of discount bonds (Sec. 4*C*) for sale to small investors. This type of bond is not used much in private finance.

State bonds, like federal issues, are based solely on credit but are issued through banks. Bonds of local governments occasionally are secured by mortgages when they are issued for the construction of an improvement which would be a financial asset in private hands—a highway bridge, for example, which serves as the security. More frequently, they contain stipulations resembling those of private debentures, designed to protect the lenders.

Since local communities are very prone to issue bonds for improvements which could be paid out of tax receipts if the communities would raise tax rates sufficiently, many of them have more bonds outstanding than they can pay interest on easily. For this reason many states have passed laws or have constitutional provisions limiting the amount for which cities, counties, and towns may bond themselves. This is known as the *legal debt limit.* If a community has issued bonds for road or schoolhouse repairs, or for other current expenses which should have been met from current taxation, to a point where its debt limit is reached or approached, it may be prevented from bonding itself for the acquisition of local public parks or forests, no matter how desirable or even urgently they are needed. Congress from time to time places debt limits on the federal government's borrowing activities, but there are no constitutional limits on them.

As stated in Section 3*C*, when bonds are issued, it is necessary to make provision for their payment when due. In public as well as in private business, the sound procedure is to set up a sinking fund (Chapt. VII, Sec. 6) for this purpose. For bonds not issued for a

[1] In times of stress a strong government can almost force large investors to buy its securities.

direct revenue-producing improvement, sinking fund payments into it ordinarily must be made from tax receipts. If the improvement is directly revenue producing, a proper proportion of its receipts should be placed annually in the sinking fund.

D. Advisability of Public Bonding. The extent to which governments should go in financing public works by bond issues is a matter of great dispute. Almost every one will agree that for certain types of public improvement, namely, those of large magnitude and great necessity, bonds are essential and that for ordinary current expenses they should not be used except in times of the gravest emergency. In specific situations the arguments pro and con are apt to hinge on two questions: Have people of the present the right to hand a heavy debt burden onto their descendants? Will the public credit be able to stand the strain of the borrowings? The answer to the first question usually depends on the nature of the improvement. Public borrowings, such as the kind that New York State has made for public forests, will benefit future generations more than people now living, and expenditures that are made now justly can be paid for by those who get the benefits. A school building which will be worn out in twenty years should certainly be paid for before it has to be replaced.

The question as to how much borrowing a national government can indulge in without risking its credit is a difficult one. Governments have enormous powers of control over the economic life of their people, which gives them great possibilities of stretching their credit. Whether present large-scale borrowings of the American government are dangerous to its future credit is, perhaps, a question to which no one really knows the answer. In a grave national crisis that calls for greater expenditures than could possibly be met from taxation, such huge borrowings are necessary, but the more a war can be financed from taxation, the less the future strain on a country's economy.

The credit of state and local governments, having no such broad powers as the national government, is more easily determined, and hence it is less easy for them to risk their credit by unwise borrowings. Perhaps the final answer in both cases is simply, "Does the return from the borrowings increase the public wealth by adding to its permanent improvements sufficiently to justify their being made and increase the income-producing capacity sufficiently to pay interest and principal?"

CHAPTER IV

NATURE OF CAPITAL AND CREDIT

In Chapters II and III finance and business were discussed from the viewpoint of those who are engaged in private or public enterprises and need to borrow money or obtain credit in order to start, carry on, or expand their activities. This is only part of the story. In order to understand forest finance it is necessary to understand: (1) the source and nature of funds which are borrowed or which serve as a basis for credit; (2) the general nature of capital and its relation to credit; (3) the mental attitude toward investments of those owning or controlling funds.

1. SOURCES OF BORROWED FUNDS

All the funds loaned directly or indirectly have been saved by some individual or group who, not needing them for the immediate purposes of life, lends them to other individuals, enterprises, or institutions willing to pay interest for their use. These savings have resulted directly or indirectly from the application of labor and brains to the preparation of natural resources for human use, these being the ultimate source of all wealth.

Since the development of our present form of civilization, people have been making savings for themselves whenever their earnings exceeded their expenditures or have been creating savings for others by working for them. Every man productively employed in a profitable business enterprise adds to its earnings, and its corporate earnings will profit those who have invested in it, loaned it money, advanced credit to it, or worked for it.

Not all saving is voluntary or intentional or of a personal nature. The laborer is seldom interested in making savings for his employer; yet, if he is "worth his wages" and the enterprise is profitable, he cannot help doing so. No one pays taxes for the fun of it; yet those taxes, if expended for productive public improvements, as highways and national forests, represent an increase in public capital investment. The part played by involuntary savings in growth of capital is large. Up to a point, the accumulation of savings is cumulative. The more one saves, the easier, generally speaking, it is to save.

Out of these accumulated savings of several centuries have been built the world's industrial plants, railways, steamship lines, financial institutions, homes, roads, schools, parks, armaments, and everything we own, both privately and publicly. Public improvements, built through taxation, are only possible when private saving has risen to a point where it is possible to raise the necessary tax revenues; public borrowing is only possible when savings have accumulated sufficiently and there is a sufficient tax base (Chapt. XVII, Sec. 4) to pay interest on the loans.

When a person, a company, or the general public puts its savings into an enterprise which it expects will yield a direct or indirect profit, it is said to *invest* in that enterprise. The enterprise itself is known as the person's or company's *investment* and they are known as *investors* (Chapt. V).

2. WEALTH AND CAPITAL

The great physical plant of civilization, plus its land and other natural resources, plus its human resources in character, brains, technical skill, and brawn, make up its total *wealth*. The physical plant alone, strictly speaking, is its *capital*, excluding land and other natural resources. It is frequently convenient, however, to consider as capital the natural resources such as timberland, especially when it is owned by an operating concern having a mill, logging camps, and other necessary equipment.[1]

Economists are careful to specify that capital is not money, but the means of production and the necessary raw materials for that production. However, all these things have a monetary value and, therefore, are usually expressed in terms of money. When we say that a company has a *capital* of $600,000 or $10 million, we mean that it owns or controls property, such as real estate, mills, raw materials, finished goods, stocks, bonds, cash, estimated to be worth that much money. If, however, one says it is *capitalized*[2] at so many thousands of dollars, he refers to the total par value of its stock, the original term for stock having been "capital stock" (Chapt. III, Sec. 3).

The capitalization of a company remains the same, even though the market value of its stock may change from day to day, unless its

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[1] The term "forest capital" may be defined as the land, timber, other vegetation, and physical improvement such as roads and fire towers that make up a forest property.

[2] So used, this term must not be confused with "capitalized value" as determined from earnings (Chapt. VI, Sec. 8*I*, and Chapt. VIII, Sec. 1*B*).

stockholders change the capitalization by issuing more stock, changing its par value, or reducing its amount. The amount and money value of its capital change constantly, owing to many factors, such as changes in amount and value of raw materials, equipment on hand, and variations in value of money (Chapt. VII, Sec. 3).

From a business viewpoint, capital may be *liquid, frozen, fixed,* or *working.* Liquid and frozen refer to the ease with which it can be converted into money. This depends on the form of the capital and on business conditions. Capital in young timber, which ordinarily cannot be converted into cash before it matures, is considered frozen. A carload of lumber ready for immediate use is usually liquid because it can be sold easily. In times of severe economic depression it may be frozen because no one can afford to buy it. Both terms are relative; no capital is completely liquid or frozen at all times.

Fixed capital is capital invested for long periods in raw materials and in the equipment to turn the materials into cash; thus the timber in a forest, the mill, and permanent logging roads is fixed capital. Working or circulating capital is money which is used to operate the machinery for turning the fixed capital into profit by manufacture and sale, plus the money tied up in materials in the process of manufacture and in finished but unsold goods. The amount of fixed capital depends upon the magnitude of the enterprise and the length of time it intends to operate. In operations such as mining minerals or forests, the amount declines with each unit of product removed.

The amount of working capital necessary in an enterprise depends on the size of operations and on the time necessary to complete the turnover of a single unit of raw material to the finished product. Thus, if a small lumber operator manufactures and sells the entire output of a single set-up of his mill in 6 weeks, the working capital that he has expended in buying stumpage, hiring labor, and other expenses of current operations will be returned to him when he sells the lumber. In a river-driving operation the logs may take 3 years to reach market; so the money invested in them cannot be regained for at least that time. The turnover period in the first instance is 6 weeks, in the second, 3 years. The average turnover period for working capital is about a year. Working capital, therefore, may be considered a rotating fund, out of which expenses that cannot be met from current earnings are paid until receipts came in. Its amount varies from day to day but, unless the scale of operations changes, averages about the same from year to year. It may be borrowed on short-term loans or obtained by discounting expected receipts (Sec. 6). When the amount is temporarily in excess of current needs, some money may be placed

at interest in short-term loans. It is considered sound for a business to expect a return on working as well as on fixed capital.

3. THE USE OF CAPITAL IN BUSINESS

When capital in the form of money is invested in a new manufacturing business, it is used to buy materials and equipment and hire labor.[1] One of several things may happen to it. (1) If the business is badly managed it disappears, partly in wasteful operations, partly to satisfy creditors of the business when it fails; it is not lost to society, but falls into other hands and is broken up into small parcels. But, if the supply of resources and the equipment is completely destroyed, as happens in a coal mine explosion followed by a fire, all the capital that has not passed into other hands by payment of wages, purchase of equipment, and the like, is irreparably lost both to the owners and to society. (2) Ordinarily, if a business can operate continuously in one locality and has no particular raw-material problem, as a textile mill, the original capital remains in the mill, always producing a stream of profits, subject, however, to changes in value (Chapt. VII, Sec. 5). But, if the business is one that must terminate when its raw material is exhausted, as a coal or timber mining operation, the capital that was first converted from money into ownership of the coal vein, stumpage, mill, and other equipment must be reconverted into money before the coal or timber is exhausted, to be invested in a new supply of raw material, plant, and so on. Thus, when a million dollars is invested in a lumber operation, if the company is to stay in business, this sum must be set aside from earnings for reinvestment in more timber and a new mill when the first purchase is exhausted. The setting aside of a certain sum annually from profits to preserve capital intact is known as *capital recovery* or *turnover* (Chapt. VII, Sec. 5).

4. INVESTING SAVINGS AND CAPITAL

A. Direct Reinvestment. If an individual, a company, or a public agency immediately spends the money it earns on new means of production, it is directly investing its savings to increase the scope and profit of its business. Thus, when a farmer uses part of the profit from the sale of his crop to buy an improved harvester, he expects that its purchase, by cutting down his future labor bills, will enable him to increase his future profits. The lumberman who puts part of his earnings into an improved mill does the same thing. Both the

[1] After the enterprise is well started, labor must be paid from gross income.

farmer and the lumberman are improving or increasing not only their own productive capacity but that of their communities as well. When part of the tax receipts of a county is expended for a modern bridge to replace one that the traffic has outgrown, it is likewise increasing the productive plant of the community. Does not the new bridge make it cheaper for both farmer and lumberman to market their product?

B. Indirect Investment. The above are all examples of the direct investment. This is only one method, and usually the least common method, of investing savings even when they are invested in the owner's own business. Few businesses or public agencies receive enough income from specific transactions or over short periods to do much financing. Generally, earnings must be allowed to accumulate until they reach sufficient volume to be expended usefully to increase production or to purchase raw materials. Because it is costly and hazardous to store cash in office safes, it is usually deposited in banks, which afford it safekeeping and increase its original amount by interest.

C. Nature and Functions of Banks. The primary business of a bank is to hire and loan money. It makes its profits by paying a smaller rate of interest for the money it hires than it obtains for the money it loans. When $100 is put into a savings account, the bank pays so much a year for its use and lends it to some one else for enough additional money to pay its own expense and to make a profit. In checking accounts, interest ordinarily is not paid and sometimes small fees are charged. In this set-up the bank acts only as a depository and clearing house. Although it may lend a part of such funds for short periods, it cannot use them for long-term loans because the depositors may call for them at any time.

The great bulk of the savings of individuals and businesses is deposited in banks. These funds may remain indefinitely in savings accounts or in other types of interest-bearing accounts; or they may be withdrawn for the purchase of investments that bear a higher rate of interest, such as stocks, bonds, and mortgages; or they may be put back into a business. Banks make short-term loans of working capital to businesses and make loans to farmers on the security of growing crops or livestock; or they invest in mortgages, stocks, or bonds; or they lend to other banks that have greater facilities for making loans. Banks are required by law to set aside a cash reserve sufficiently large to meet all expected needs of depositors who may make sudden withdrawals. Likewise they are legally limited as to the type of loans they can make, in order to safeguard the depositors' money.

Most banks, particularly those in smaller communities, do not have sufficient deposits to do much long-term financing, such as underwriting of industrial or public bond issues. *They may even be obliged to* borrow money from larger banks in order to make small local loans. Large issues are usually "floated" by larger city banks and other financial institutions which specialize in such business. These banks, often called investment banks, frequently borrow the funds for this purpose from smaller banks and sell the issues to investors. The same methods, in somewhat different form, are used to float new stock issues. Consequently, most financing of large and medium-sized enterprises is done directly or indirectly from large financial centers. It is the small sawmill operators and not the big lumber companies that are financed locally.

As might be expected, the people who control these large financial institutions not only fix the terms under which money is loaned but also exert a large influence in the affairs of the companies they finance. Frequently, representatives of the financing banks are elected to their boards of directors. Through interest payments, percentages on sales of securities, and the like, much of the proceeds of industry pass into the control of these institutions.

D. Individual Small Investors. The average small investor whose savings increase little by little is seldom able to buy enough stock in a company to exercise any managerial control over the business in which he invests, even though it be a relatively small company in his own community. Often the securities of such companies are too high-priced to yield much income. Moreover, their value does not fluctuate so that there is much chance of purchasing them at a low price in the hope of selling them later at a high one. Consequently, investors often put their surplus income into life insurance or purchase securities of large utility and industrial companies, which, if bought judiciously, not only yield interest but also may increase in value. Thus, the use of their savings passes out of their communities and into the control of large financial institutions in the great population centers (life insurance companies are among our greatest financial institutions), where they join the vast aggregation of capital and further help to increase the power and the scope of operations of those who control them.

5. CREDIT

Heretofore we have considered credit as synonymous with the advance payment of sums due at a later date, as when a wholesale lumber dealer pays a sawmill man for lumber not yet cut, in order that

the mill man may have the money with which to cut it. Under other circumstances, the mill man may ship a carload to a wholesaler expecting to be paid only when the wholesaler has sold it. In the first case, the wholesaler is advancing *credit* in the form of *cash* to the mill man; in the second, the mill man is advancing *credit* in the form of *lumber* to the wholesaler. Another important difference is that the wholesaler advanced money for goods not yet in existence. In the second illustration, the goods were advanced on the expectation that the wholesaler would be able to sell them and that both parties would get their money. By expanding these two ideas to a large scale, it is apparent why capital is in itself a form of credit. It is goods or money advanced in expectation of future payment from the sale of goods or services not yet in existence.

It becomes evident that the active use of capital generates credit, which, temporarily at least, further increases the amount of capital available. A simple example will show the principle involved. A wholesaler agrees to take a consignment of lumber from a mill man who needs cash in order to manufacture the lumber. Not himself having the cash in hand, he gives his note to the mill man, promising to pay in ninety days. The mill man takes the note to his bank and has it discounted (Chapt. VI, Sec. 3). The note immediately becomes an asset of the bank and is used along with other notes as security for a loan the bank wishes to get from a larger bank in order to give a mortgage, on which a man can get money to build a house. The first bank can then use the mortgage on the house as security for still another loan it wishes to make, and so on. It should be noted that *all these transactions are based on the expectation that goods will be manufactured, houses built, and sales made. If they are not, the whole credit structure falls.*

In the realm of high finance, the same types of transactions occur, only in greater complexity and volume. The securities of one company are lent as a basis for the credit of another to be organized. The first may not yet be in a position to make earnings; the second cannot hope to make a profit for a long time after it is organized. The sale values of stocks rise in anticipation of future increased earnings until it becomes difficult or impossible to tell what is really capital, based on present and reasonably assured future earnings, and what represents credit, based only on unjustified optimism.

This whole process is known as the *pyramiding of credit* or *credit inflation*. Sooner or later, if carried too far, it results in a financial crash that is accompanied by great losses of paper values (and some-

times of real values), general economic disturbances, and public suffering, such as took place between 1929 to 1933. The use of credit is a necessary business procedure—business on any scale could hardly be carried on without it—and increases the rate at which business can expand by increasing the effectiveness of capital. But, if credit inflation is carried too far, it is socially destructive.

6. THE CONTROL OF CAPITAL AND CREDIT

The control of the vast reservoir of capital and credit tends more and more to pass into the hands of those who control the great banking and financial institutions. There are, however, in smaller cities and towns, local reservoirs under the influence, but not always the complete control, of the great centers.

Control of private capital is subjected to such restrictions as the federal government puts on it through its currency-control powers, Federal banking acts, the Federal Reserve Banking System, anti-trust laws, and the Securities and Exchange Commission. The groups that control the great financial institutions are not always in agreement and frequently work at cross purposes as they compete to lend and borrow money, even though they are activated by the same general motives.

This whole process of control is so vast and intricate that it takes on a sort of impersonal quality, which one unconsciously acknowledges when using such expressions as "the power of capital," or "capital thinks." Sometimes capital and credit seem to be independent forces that escape the control of business men, bankers, investors, capitalists, or governments and, through credit or currency inflations, price collapses, or startling rises, runs amuck and almost wrecks society in economic tornadoes called economic depressions (compare Chapt. VII, Sec. 3, and Chapt. VIII, Sec. 3*J*).

Those who attempt to control vast aggregations of capital and credit usually keep a portion of their capital in conservative investments of low interest rate, to give it stability. The rest of the capital is used for less stable investments of presumably higher interest rate, many of which are of a frankly speculative nature, in a gamble for high profits. They do this by constantly shifting their investments from one enterprise to another, to obtain the highest rates of interest, and by buying securities for price rises and selling them to forestall price drops. Their object is to keep a portion of their capital as liquid as possible so that they can direct its flow toward the largest source of profit. When income from an investment dwindles, they immediately

check the flow of capital into that enterprise and divert it into another channel where the income is greater.

Capital can be pictured as the contents of a vast series of interconnecting reservoirs, the largest ones in the great financial centers. They grow progressively smaller, until we reach the country bank and the cross-roads store. Channels run from the larger to the smaller reser-

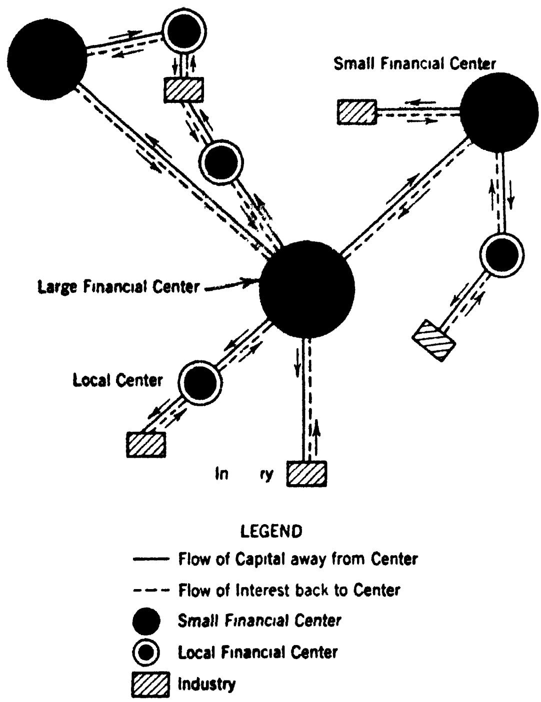

FIG. 1. Diagram illustrating the flow of capital loans from larger to smaller capital markets and to different industries, paralleled by a return flow to the larger centers of interest and profits on the loaned capital.

voirs and the current flows both ways. From the larger to the smaller reservoirs run streams of capital; from the smaller to the larger, run streams of profits from its use. Each reservoir has its own system of incoming and outgoing streams, as a local traffic system not directly connected with the great arterial streams connecting the larger reservoirs which feed its locally owned industries and businesses. The streams of outgoing capital increase the streams of incoming profits from its use, and the streams of incoming profits increase the size of the outgoing capital. Figure 1 attempts to represent this flow graphically. The contents of reservoirs and the rate and amount of flow of

both sets of streams are increased by credit inflation and are decreased precipitantly when the inflation bubble bursts. The exhaustion of all natural resources would drain the system completely. The exhaustion of the forest resources of regions where they are the chief source of income sometimes drains the local system of that region.

The attitudes of those who attempt to control capital differ somewhat, depending upon whether they are operating in connection with the large or the small reservoirs. This is discussed in the next section.

7. "LOCAL" AND "OUTSIDE" CAPITAL

By *local capital* is meant that which is owned, invested, and controlled within a more or less restricted region, as a state or group of states. By *outside capital* is meant that owned and controlled in a region distant from the one in which it is invested. Outside capital usually is owned or controlled in large financial centers or sometimes in foreign countries. Thus, of three pulp companies operating in Quebec, the one in Montreal is financed by local capital, the one in London is financed by outside capital, and the one in New York (from the Canadian point of view) is financed by foreign capital.

Usually it is to the advantage of any region to have its industries financed by local capital not simply because more of the profits remain in that region, but if an enterprise is locally owned, ordinarily its management also is local and therefore less likely, when there is a possibility of greater profits elsewhere, to withdraw its capital suddenly without concern as to the local consequences. Local management is more likely to have an enlightened labor policy, because of a desire to create purchasing power in its community, which is of direct assistance to them in the variety of local enterprises in which they are engaged, than is outside capital which seldom controls more than one or a few of the enterprises of a community.

If the enterprise utilizes natural resources, such as forests, which can be renewed if treated properly, it is obvious that local capital should have a greater interest than outside capital in handling them conservatively because their exhaustion reduces the wealth of the region from which their income is drawn. It does not follow that those who control local capital always understand this fact or act accordingly if they do. On the other hand, outside capital, being more abundant and stronger, may be better able, if it desires, to meet the extra investment costs which conservation demands.

Not all regions have sufficient capital to finance their own industries. This is particularly true of the regions that have large natural re-

sources and little economic development. In such regions these resources must be developed by outside capital, which will inevitably leave some of its gains in the locality—chiefly through payrolls—and to some extent, therefore, build up that region. Here it is good policy for the region to utilize the capital as it accumulates in order to obtain control of these outside enterprises. Enormous amounts of European capital went into our American railroads and businesses in general when our great expansion began seventy-five years ago. Most of it has been paid off, and American enterprises are now, if not entirely American owned, at least American controlled.

It is from the large capital markets that money for investments in large-scale private forestry must come. Those seeking it must be prepared to deal with the attitudes of mind and with the criteria of soundness of investment and of probable profit that dominate these markets. Smaller ventures in forestry likewise must convince the lenders in their local markets of these points. As matters stand, both those wishing to engage in forestry on a large scale and those desirous of doing it in a smaller way do not have an easy task in obtaining capital for their enterprises (Part III).

8. CAPITALISM OR THE CAPITALISTIC SYSTEM

The system of building up industries from accumulated savings of many people, relatively few of whom control either the industries or the disposition of savings, or capital, is known as the *capitalistic system.* It is the economic system under and by which most of the civilized countries of the world live. It exists in two main forms. The first is *industrial capitalism,* where the real control of the capital lies in the hands of leading industrialists, who, having built up their own business from earnings or having paid off their debts, are in a position of economic leadership if not economic dominance. As businesses are consolidated, they deal with larger and more powerful banks, and ownership of their securities becomes more widely dispersed. As investment by a large group of people begins to be made in life insurance policies and savings banks or through holdings of stocks or bonds in small lots, they no longer have any effective control over the destinies of the concerns in which they invest. These same concerns turn more and more to large banks and financial houses. The houses whose business is the manipulation of funds become the controlling factor in the economic scheme, reducing the industrialists to a secondary financial position. Capitalism in this form is known as *finance capitalism.*

Fifty years ago the United States was in the stage of industrial capitalism. Today we have entered the stage of finance capitalism although industrial capitalism still exists. It is conceivable that later, by virtue of the increasing power of government in business and finance we may enter the stage of *state capitalism,* under which the government would own or control most of the supply of capital. If this should arise, we would have a condition under which the government would direct, through this control, the economic conduct of all major industries. If this control were by a democratic government, state capitalism would be very close to socialism but not strictly the same because socialism is generally based on the theory of complete or practically complete public ownership of all natural resources and means of production. Since, in the last analysis, control accomplishes all the results of ownership, the results, good or bad, may be practically the same. State capitalism already exists in practice in certain totalitarian countries. So far it does not appear to have worked to the advantage of the inhabitants—much less to the advantage of their neighbors.

9. THE SOCIALISTIC AND COMMUNISTIC SYSTEMS[1]

A discussion of the theoretical aspects of socialism and communism or of their virtues as social systems has no place in a text of this kind. However, it is necessary here to point out certain of their financial aspects.

Every government in a capitalistic country has found it necessary for the public good to engage to some extent in socialistic activities. Ownership and operation of large areas of public forests and operation of park systems, of game refuges, and of the like are examples in the province of forestry. Other diverse examples are operation of roads, of educational systems, of public power systems, of railroads, and of the post office. The reason for these socialistic enterprises in countries largely dominated by the capitalistic system is that in all these countries it has not proved possible for these things to be operated privately on a sufficiently large scale to take care of public needs. In some situations private capital could not operate them at all because there would not be sufficient, if any, profit, nor would it be possible to finance them privately on a sufficiently large scale. Large state and city park systems are examples. As society increases in complexity, there appear to be a growing number of such fields, necessary for the public wel-

[1] The difference between socialism and communism appears to be in technique rather than in principle; hence, for our purposes, they may be considered together.

fare, in which private initiative cannot successfully operate at a profit or is not satisfied to operate at a low enough profit to give adequate public service, and which, therefore, will have to be covered by the public itself.

It is a fallacy to think that socialism or communism as a universal system would do away with the need for capital. A fully socialized society presumably would be one organized somewhat like a huge corporation conducting all the business of society, the members of which would be the stockholders, their control operating through the ballot box. This corporation still would need to make savings, investments, and borrow funds in order to carry on its ordinary business as well as to expand its activities, renew its worn-out plants, and so on.

CHAPTER V

THE NATURE OF INVESTMENTS

It is impossible to consider forestry as an investment without first considering the nature, kinds, and characteristics of investments in general. Forest investments are considered specifically in later chapters.

Broadly speaking, any expenditure made with the expectation of a future gain is an *investment.* Investments may be for other purposes as well as for financial gain. One who buys tickets for a theatrical performance has invested his money for a recreational purpose. The father who pays his son's expenses in college is investing in his education because he desires to see his son do well in life. The federal government buys millions of acres of denuded lands on the headwaters of streams. Much of the land is of such poor quality that forestry will never pay its own way on it; but, if it is allowed to remain denuded, the resulting erosion will destroy farms and other property downstream. The government may be said to be investing public money for social and community welfare without expectation of direct financial gain.

1. CAPITALISTS, INVESTORS, AND ENTREPRENEURS

Ordinary investments are made with a view of direct financial gain to the investor. Investors may be divided broadly into two main classes: (1) those who use their own funds or borrow funds from others to engage in business and (2) those who buy physical property, mortgages, stocks, bonds, etc., with the expectation of deriving a profit without directly engaging in productive business in connection with them. The first class are known as business men, or to use the economist term, *entrepreneurs;* [1] the second, as *investors* if operating on a small scale, *capitalists* if operating on a large one.

[1] This is a French word sometimes badly translated into English as "enterprisers." It is only partly equivalent to the American term "business men" and really refers only to those who are in business for themselves. In these days when most business is organized in corporate form, the stockholders are theoretically the entrepreneurs although, as a practical matter, only those whose holdings are sufficient to enable them to participate actively in the management of the company are really entrepreneurs. The small stockholders are simply investors.

It stands to reason that the entrepreneurs who borrow money to engage in a business expect to make money enough to pay for the use of what they have borrowed plus enough to satisfy their own needs. If they use their own capital, they expect to make more from its use than if they had invested in something else. If they fail to make a higher rate of interest on the money invested in the business than the interest rate at which the money is borrowed, they go broke. If they use their own capital, they are not getting full value for the use of their own money unless it pays them more than they could get by lending it. The difference between the profit of the capitalist or investor and that of the entrepreneur is known as *entrepreneur's gain.* This may be expressed in terms of interest rates as follows. Suppose a business is based entirely on capital borrowed at 4 percent. On the use of this capital the entrepreneur obtains a return of 10 percent. The entrepreneur's gain is then 6 percent.

The impression should not be gained that the entrepreneur is, in the accepted sense of the terms, either an investor or a capitalist. He is so only in so far as his own money is invested in his business. With the gradual extension of finance and its accompanying banker control of business and industry, the entrepreneur tends to become less of an investor in his own business and is fundamentally a borrower. If his borrowing becomes too extensive, the enterprise tends to pass into the control or ownership of the capitalists, represented by banks and other financial institutions, and his position becomes more and more that of a hired executive. The capitalists, in a sense, become the entrepreneurs, once removed from immediate details of management, and as such tend to absorb the entrepreneur's gain.

A little reflection will make it evident that the entrepreneurs and the laborers whom they hire are the initial producers of capital in a capitalistic society. It is they who turn natural resources into usable form, who distribute goods and provide services and by so doing enable the building up of further capital to be lent to other entrepreneurs who continue the process. If there had never been any entrepreneurs or laborers willing to work for them, there would be little use in saving, from which the investor and the capitalist and the world in general profit. Without the brains and energy of the early lumbermen entrepreneurs who started and organized the American lumber industry more than a century ago, plus the brawn, daring and physical skill of their hired lumberjacks, the country could not have been supplied with an abundant, cheap, and easily handled material for building homes, factories, and all sorts of other things which went into the rapid ex-

pansion of American life and of the world as a whole. Without the services of the investors and capitalists who supplied capital and credit, the building of this huge industry would have been much slower and the price of a vital commodity much higher.

However, the work of the entrepreneur, like that of the capitalist, can be socially destructive, even when financially profitable to those concerned. The business of selling narcotics is said to be highly profitable; nevertheless, the human wreckage caused by their unrestricted use makes it necessary to control the business legally and thus to restrict the profits of both the entrepreneurs and the capitalists who engage in it or lend money to the business. A business may be socially constructive in some of its activities and socially destructive in others. The activities of the entrepreneur lumbermen and their capitalist backers who logged off the Lake States, while performing a socially useful function in providing a vitally necessary material for the nation as a whole, also by destroying almost completely the most important source of income of a whole region, performed a socially undesirable operation, for that particular region.

2. CARRYING CHARGES ON INVESTMENTS

Investments cost the owner something to hold or, in financial parlance, *to carry*. Most stocks and bonds are taxed on their earnings. A man says he invests in a house "to save paying rent." Actually, he saves only part of his rent bill, for he has to pay taxes, repairs and upkeep, and, if he borrowed the money, interest on the mortgage. A lumber or pulp company buys a tract of timber land for future use, knowing it will not be cut for ten years. The purchase price is not the end of the matter. Taxes must be paid on the land; it must be protected from fire and theft; and interest must be paid on the money invested. Likewise the same charges occur when a tract of young timber is purchased or when a plantation is made with the expectation of future profit. All these costs are known collectively as *carrying charges*. They must be met, usually on an annual basis, sometimes at longer or shorter intervals. In an investment yielding a current revenue, they can be met from this revenue. In investments, such as mature timberlands held for future cutting and immature timber or plantations held for growth, there is little likelihood of any revenue's accruing from them until they are ready for harvest. Consequently, the owner each year is adding a sum to his immediately non-income-producing investment, which he must borrow or withdraw from other sources of income. These charges, plus interest on them, naturally

must be deducted by the investor from his profit when the investment matures (Chapt. VI, Secs. 1 and 9).

3 KINDS OF INVESTMENTS

For our immediate purposes investments may be classified as follows:

1. Those expected to yield a profit from current interest payments (current payment investments).
2. Those expected to yield a profit from interest payments starting after a considerable period (deferred payment investments).
3. Those expected to yield a profit from future sale over present purchase price.
4. Those made with the expectation that the property purchased will pay off purchase and other costs when exploited and yield a profit (self-liquidating investments).

Examples of investment 1 are stocks, bonds, mortgages, regular rentals on buildings and other property, and anything else which pays income more or less regularly. Such investments may be for a term or may be more or less perpetual. Bonds are retired after a term of years, but stocks, in theory, pay forever.

Examples of investment 2 are all investments that require a considerable expenditure of time and money or both before they reach an income-producing stage. Nearly all investments in forestry belong in this class. The establishment of an airline over a new route, with the expectation that several years must elapse before operating costs will be sufficiently low and traffic large enough to yield a profit, is one example from another field. Investments of this type are not sold as such to the public but are financed either out of earning or by the sale of bonds. If financed by the sale of bonds, the issue is made sufficiently large to meet interest payments out of the capital borrowed, as they come due, until the investment begins to yield a revenue. Otherwise they would not be attractive to either capitalists or investors.

Examples of investment 3 are investments which depend not upon the earning of regular return on money invested, starting either immediately or after a considerably long period, but upon their sale at a higher price at a later period. The purchase of a lot on the outskirts of a city that has a growing population is an example. The purchaser has no intention of using the lot but figures that sometime in the

future, when the city has expanded, he can sell it for enough more than he paid for it to yield him a high profit. In one way of speaking, he is not making an investment at all but a speculation in real estate. However, since the line between investment and speculation is not very definite (Sec. 4), it is treated here as a form of investment.

If his speculation is successful, his profit is known as *unearned increment,* so-called because his action in no way increases the value of the land. He simply profits from the growth of the community. It is difficult to see, however legitimate his activity, that it is socially useful. In some of its aspects land speculation may have disastrous social consequences, as when it creates a scale of fictitious values for the land, not justified by either present or prospective earning power, and so encourages purchasers. Buyers of the land, intending to use it for its earning power, lose their investment. The history of speculators in the Lake States who sold cutover pinelands to prospective farmers for farmland, knowing that the lands were useless for that purpose, is not edifying, regardless of whether or not speculators paid higher income taxes as a result of their transactions. Certainly neither the purchasers nor the local communities gained by them, and a great deal of unwarranted suffering resulted.

However, large fortunes have been made—and lost—in this type of investment not only in city real estate but also in timber, farm, mineral, and oil lands, in power sites and other natural resources. This form of investment is more often carried on by individuals than by companies, although real estate companies sometimes engage in it.

Common examples of investment 4, self-liquidating investments, are those in natural resources, such as oil and mineral deposits and forests acquired with the intention of converting them into finished products within a definite period of time, obtaining a profit on the conversion, and recovering the capital invested. The enterprise is then closed and the capital can be reinvested. All lumbering and mining operations, no matter how long they last, are self-liquidating (Chapt. I, Sec. 5). A true forestry enterprise, however, is presumed to last forever, just as a railroad or a steel mill, some of or all the invested capital remaining in the business.

Most of the above types of investment overlap to some extent. The purchaser of stocks or bonds hopes that they will appreciate in value so that, in addition to the interest he receives, he may sell later at more than he paid for them. The investor in natural resources, not yet ready for production, hopes that their sale value will increase so that, if he desires, he may sell at a profit rather than exploit them personally. The purchaser of lands for speculative purposes may hope

to use them as security for a loan. A self-liquidating investment in a mine may pay annual returns for a half a century before liquidation is complete. An investment in young timberland, intended for clear cutting when mature, is both a deferred payment and a self-liquidating one.

Another classification of investments, sometimes helpful, is into so-called "paper investments" and into investments in real property, paper investments being, of course, such things as stocks, bonds, promissory notes.[1] As explained in Chapter IV, their owner has little control over them, and they frequently amount to nothing but claims on future profits (Sec. 4). Real-property investments consist of such things as lands, buildings, and forests, in which title and responsibility of management rest with the investor. Each class has its advantages and disadvantages. The investor in real property usually has heavier carrying charges to meet, but he is generally exposed to fewer hazards of loss from inflation, depression, financial manipulation, and poor management. His property is always there, and frequently he can do something about it even under adverse circumstances. If he can afford to hold it, he may come through at times better than the investor in stocks and bonds. Since there are risks in all kinds of investment, the next section is devoted to further discussion of them.

4. THE RISKS IN INVESTMENT

No investment of any kind is 100 percent safe. There is always an element of risk regarding both the profit and the original capital invested. A concern may fail, because of improper management or other factors, to earn dividends or even pay interest on its bonds; or it may fail completely, in which event its stock will be worth nothing or only a nominal sum, and the equity behind the bonds will be so small that, in winding up its affairs, the bondholders may lose most of what they put into them. Even in a prosperous concern the investors may lose most of their investment through financial manipulations of a few unscrupulous "insiders." Changed value of money, due to inflation, currency manipulation, or other factors, may leave the capital intact and the interest still being paid; but the lowered purchasing power of money, resulting from these changes, may actually decrease both capital and interest. In general, bonds, particularly mortgage bonds, are considered safer investments than stocks because

[1] Mortgages, although classed as real property, generally have more of the nature of paper investments, particularly when they are owned by groups of investors.

they are secured by a legal obligation to pay both interest and principal and, if they are not paid, the bondholders may take possession of the property of the company to enforce payment. But, if the property is not worth the amount of the bonds, the investment is lost. If the stockholders of a company do not receive dividends, their only recourse generally is to sue the company's officers for improper management of the company's business—an unsatisfactory and usually futile procedure.

The bonds, obligations, or debts of national governments and their political units, even though they are seldom secured by mortgages, are usually considered safer investments than either bonds or stocks of private corporations. Governments do everything possible to sustain their credit and can always raise revenue by taxation. Likewise, in one way or another, they enforce a measure of fiscal control over their subordinate units, which tends to sustain their credit. However, governments are free; if they can get away with it, they repudiate their debts, that is, they refuse to pay them either directly or indirectly. The refusal of the Soviet government to pay debts of the previous government of the Czar was an example of direct repudiation. After the first World War, Germany deliberately inflated its currency to the point where neither principal nor interest was worth anything—an example of indirect repudiation.

Investors who purchase young timber for future growth or who establish forest plantations face a set of risks not so commonly faced by purchasers of ordinary securities. These hazards are of two natures: those of forest fire, fungous, and insect attacks, and those of price changes. The first type can be guarded against by proper protective measures. To some extent these hazards decrease with the increasing size, distribution of species, and age classes of the forest. Price changes, of course, affect the value of every commercial investment because they affect the earning power of the businesses involved, but in a going concern they usually can be foreseen more or less accurately for short periods ahead. But who can foresee the price of timber or pulpwood thirty years hence? Against this may be argued that in current business, goods must usually be produced daily regardless of selling price, but one who has purchased young timberland does not need (so long as he can meet the carrying charges) to sell or harvest it at any particular time. He can wait until the price is right. The value of the land itself may also increase. In short, the investment is a real and not a paper one. The whole question of forests and forest lands as investments is considered more in detail in later chapters.

The risk in real estate or in other types of investments or speculations of "purchase for a rise in price" is largely the risk of the investor, having guessed wrong as to the future rise, as to the amount of the carrying charges, or as to the purchasing power of money (Chapt. VII, Sec. 3) when the investment matures.

After the above discussion of investment risks, it should be evident that there is an element of speculation in every investment and that there is an element of investment in all but the wildest speculations. *Success in investment consists in successful estimation of the risks involved, the objective being to secure the highest possible return commensurate with the lowest possible risk.* There is also a relation between the profits from an investment and the degree of risk involved.

5. RELATION OF RISKS TO PROFITS IN INVESTMENT

It is a general rule of life that the one who takes the greatest risks expects the greatest possible profit from those risks. There are, of course, many exceptions, but, in general, the wages of men who are free to make a choice of their occupations are higher in high-hazard occupations than in low-hazard ones. The structural steel worker on a 20-story building is paid more than the carpenter who lays the floors after the structure is erected although both are skilled craftsmen. The spar-rigger in a Douglas fir logging operation is more highly paid than some members of the crew on the ground who may have more responsible positions.

Generally speaking, the safer an investment the less it returns either in interest or in possibility of increased sale value. Bonds, as compared with stocks, pay low rates of interest and fluctuate less in value. Among stocks, those of long-established and conservatively managed corporations and those under some measure of public control are subject to fewer rises or losses in value and usually pay lower dividends than those of more recently established and less well-understood businesses. Public bonds fluctuate very little in price and pay very low rates of interest and bonds of strong governments are among the most secure of "paper" investments. There are possibilities of very high profits in real estate speculation. There are also possibilities of very great losses. This is also true in betting on a horse.

All this can be summed up by saying that, generally speaking, *the less risk in an investment the less probability of either large profits or great losses. The greater the risk, the greater the possibilities of either large profits or large losses.* Naturally, the larger the sum invested,

the more important these considerations become. Generally, the larger investors can afford to take more chances for high profits than the smaller ones. You and I may be able to "invest" a dollar on a 100-to-1 shot that Iron Face will come in ahead of Tabby Cat, but only a wealthy man can afford to stake $1000 on it. We can afford to lose the dollar; he can afford to lose the $1000. If Iron Face noses in ahead of his rival, we win $100, but our wealthy friend wins $100,000.

6. TIME ELEMENTS IN RELATION TO PROFIT

The time element in investment varies from a few days or less to half a lifetime or longer, depending upon whether one has made a short-term loan or has invested in oil lands in some remote and inaccessible part of the world. In considering the relation of time to profit, we have more than one factor to consider.

In ordinary security investments, one running for a long period, say, a bond with a 40-year maturity, often is thought more desirable than a short-term bond of the same denomination, interest rate and degree of safety purchasable at the same price, because there will be no cost of reinvestment at a possibly lower interest rate until a later period. On the other hand, very short loans often are at higher rates of interest than long-term loans, but the costs of reinvestment recur frequently and to some extent neutralize the higher interest rate. In investments that can return no profit for a long period, the investor is entitled, in financial theory, to a higher rate of interest than he would get if he put his money into an immediately profitable investment although he may not always succeed in getting it. If he succeeds he is rewarded for going without returns for a long period (Chapt. VI, Sec. 5).

7. PROFIT, RISK, AND TIME AS RELATED TO THE ENTREPRENEUR

In any enterprise the entrepreneur, like the investor, must figure his business in terms of profit as related to risk and time. It was shown (Sec. 1) that, if his profit on his own capital does not exceed what he might make from investing in some other enterprise, he is, in effect, losing money; and, if he does not make a higher rate of profit on his borrowed capital than the cost of hiring it, he is also losing money. If his losses continue long enough, he loses his business through foreclosure by his creditors. In this action he loses his own capital and, frequently, his source of livelihood and status in the community as well. Consequently, his risk is higher than that of the capitalist or in-

vestor who at the most loses what he put into the venture and, through foreclosure procedure, may regain all or part of it. If he is a wise investor or capitalist, he has probably "distrbibuted his risk" by investing in numerous ventures, so that if one goes bad he will not lose all his capital. The entrepreneur, whether a single individual or a group of men who are owners and managers of a company, usually have most if not all their capital "tied up" in it.

If the entrepreneur's risk is greater than that of the capitalist or investor, his opportunity for profit is correspondingly larger. He borrows money at a definite rate of interest, but only his own abilities and the conditions surrounding the business in which he is engaged ordinarily limit his own rate of profit. He may borrow money at 3 percent and make 100 percent on it if he is able. If the business is organized as a corporation and its managers are the largest stockholders, they can vote themselves large salaries, bonuses, etc. If it is a large impersonal corporation, the real entrepreneurs are the higher executives whose degree of actual ownership is often rather small. Their opportunities, in terms of large salaries, bonuses, inside information, etc., to obtain income from the business are far greater than those of the investors. The investor has purchased bonds with the knowledge that his income will be limited to a small percentage. The investor who has purchased stock knows, if he is well informed, that, unless he has a holding large enough to enable him effectively to participate in the management of the company, his dividends will be limited to what the company cares to pay. He is aware also that the value of the stock is subject to arbitrary fluctuations not necessarily connected with its earning power.

All this is equivalent to saying that money earns more when actively engaged in business than when simply placed out at interest. The successful business man knows this, and he sells out and invests the proceeds in securities, not with the idea that he is going to make more money than he did in business but simply so that he will have enough from his investments to live on with less exertion. His descendants will probably find, if they continue to live on the old man's investments, that their income gradually declines because the investor who is not concerned with the management of the enterprises in which he has invested is at a financial disadvantage as compared with the one who has managerial connections with it.

It may be regarded as significant that the descendants of some of the lumbermen in the Lake States who chose to invest their fortunes rather than move their operations to other regions are reported to have

found their incomes decreasing with the years.[1] They might have been better off if they had remained in the lumber business, even though that business is itself, on the whole, less profitable than formerly.

At least part of the increasing control of business enterprises, often coupled with active management, by banks and other financial institutions may be interpreted as an effort on their part to secure entrepreneur's gain from the enterprises as well as investor's gain. This can be done successfully only if the banks have as much technical skill in business management as business men. Certainly almost complete banker control of American railroads has not resulted in their highly successful management.

The time element for the entrepreneur may or may not be as important as for the capitalist or for the investor. That depends entirely on their relative financial strength. A prosperous business often can afford to set aside a sufficient portion of its profits to make investments to insure opportunities for future growth—reserve supplies of raw material, for example—that would seem poor investments from an outside investor's point of view.

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[1] L. V. Armstrong, "We Too Are the People," Reviewed, *Journal of Forestry*, Vol. 36, No. 11, p. 1632, 1938.

CHAPTER VI

INTEREST AND DISCOUNT

Money is an unusual commodity in that, in the ordinary sense, it can be neither bought nor sold but only hired or lent (Chapt. VII, Sec. 3). Its rent is called *interest*. The use of interest in financial transactions goes back far into history. At various periods it has been considered immoral and has been prohibited by law. Nevertheless, no society based on a monetary economy can dispense with it. Otherwise profitable use of capital would be practically impossible. Since forestry requires the expenditure of capital and is, moreover, a long-term investment, interest is of great significance to it. Even though its importance can be overstressed, an understanding of interest in relation to forestry is vital to the forester.

The mathematics of interest is a subject in itself, called the *mathematics of finance*. Many books have been written about it. Its philosophical, social, and economic aspects also have an extensive literature.

The purpose of this chapter is to study the significance and uses of interest and discount (the latter being interest in another form), the methods by which they are calculated, and the nature of the changes in interest rates. In later chapters this material is applied to particular forest problems.

1. SIMPLE AND COMPOUND INTEREST

Since interest is a form of rent, it is calculated in terms of a time interval, usually one year. If a shorter period is used, the rate being the same, the interest will be greater. A year's interest at 6 percent, borrowed on a 6-month's basis, is $12 instead of $6.00.[1] In other words, the annual rate becomes 12 percent. Interest on long-term, simple-interest loans is generally on an annual basis, but payments may be made semi-annually. Thus, if a $1000 bond bears 5 percent annual interest, the owner receives a $25 check every 6 months, in-

[1] Small-loan companies, dealing with people of low income, frequently use a very short interest period so that even at low rates the interest speedily becomes exorbitant.

stead of an annual payment of $50. On loans running less than a year, interest is generally figured on an annual basis and divided by that fractional part of the year covered by the loan. In the absence of a contrary statement, the interest period is assumed to be 1 year.

Simple interest is figured on a fixed *principal sum.* It is not added automatically to this principal, nor does the interest itself draw interest. Consequently, the interest is the same each year. In *compound interest,* the interest of the first period is added automatically to the principal, and the interest of the following period is figured on the new principal, and so on. Thus the interest each year amounts to more than that of the preceding year. At 3 percent simple interest for 10 years, $100 amounts to $130; at compound interest, it becomes $134.40.

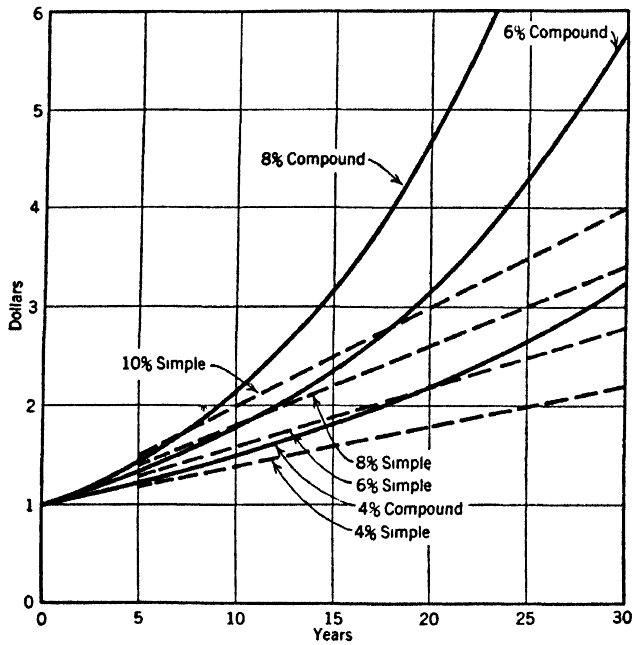

FIG. 2. Comparison between simple and compound interest on $1.00 for 30 years at various rates of interest.

The relation between simple and compound interest, illustrated in Fig. 2, brings out the following fundamental points. (1) Simple interest is a "straight-line" progression. Compound interest is represented by a curve that rises continually more steeply. Hence, the longer interest runs, the greater the difference between the same

percentage of simple and compound interest. (2) There is no obvious proportional relationship between rates of compound interest as there is in simple interest. Witness this tabulation.

INTEREST ON $1.00 AT 2% *and* 4% FOR SIMPLE AND COMPOUND INTEREST FOR VARIOUS YEARS

	2%		*4%*	
Years	*Simple*	*Compound*	*Simple*	*Compound*
10	$0.20	$0.22	$0.40	$ 0.48
20	0.40	0.49	0.80	1.19
80	1.60	3.87	3.20	22.05

(3) If two equal sums are placed at interest at the same time, one at simple interest and the other at a *lower* rate of compound interest, the sum at the lower compound rate will eventually be greater than the one at the higher simple rate.

The owner of an ordinary bond which pays simple interest receives a check at least annually, but the investor expecting compound interest must let not only his principal but also the interest on it remain in the investment. Savings banks pay compound interest, but the depositor who withdraws his interest as fast as it is earned gets only simple interest. Since most people must utilize their incomes as they are received, they are unable to take advantage of the amazing possibilities of increase inherent in compound interest; consequently the vast majority of investments and business transactions involve only simple interest.

Even people who are able to let some of their interest be added to their principal are restricted in opportunities for compounding it. Savings banks limit the size of deposits they will take from an individual depositor. Investors who reinvest earnings from simple-interest investments in other similar investment may secure compound interest, but the cost and delays of this proceeding mean that the rate will be low. Deferred-return investments (Chapt. V, Sec. 3), as will be explained, *must* yield compound interest, but the investor seldom can withdraw either capital or interest before it matures, regardless of his needs.

Consider an immature forest. Each year the new growth is added to the old. This increase is in itself a compounding process, even though we cannot say that trees grow at compound interest because the increment does not follow the same mathematical pattern (see the comparative curves in Fig. 46). Since this cumulative increase in

value cannot be realized until the stand is mature, the profits when obtained must also be cumulative. The only correct measure is in terms of compound interest. The investor's carrying charges on deferred-payment investments (Chapt. V, Sec. 3) are also cumulative. During the entire period he is paying out sums for taxes, protection, and other expenses either on which he has to borrow and pay interest or which he could otherwise place at interest. Since these carrying charges are not balanced by any current return, they are of the same nature as sums left in a savings bank on which interest is compounded. Because the owner must figure his costs at compound interest, he is entitled to his returns in the same terms (see also Secs. 7*A* and 9).

The fact that an investor receives compound interest on deferred-payment investments does not mean that he can expect the same rate of compound interest that he could get in simple interest from investments of current payment. The following tabulation shows its utter impossibility by comparing the rate of simple interest, equivalent to that of compound interest, at the end of 50 years.[1]

Compound Rate (%)	*Simple Rate* (%)	*Compound Rate* (%)	*Simple Rate* (%)
1	1.28	5	20.02
2	3.38	6	34.84
3	6.76	7	56.92
4	12.20	8	91.80

On the other hand, a precise table of equivalents between simple and compound interest does not express the relative value between a current- and a deferred-payment investment. Suppose a man had a choice of two investments of the same amount, one paying an annual return of 6 percent simple interest, the other a deferred return of 4 percent compound. At first glance, one might say that at the end of 20 years he would have made the same amount of money (Fig. 2). But suppose he had taken the 6 percent investment and reinvested the annual interest. Would he not have made more? Or suppose he discovered, after making the deferred-return investment, that he needed his interest annually. Would he not have had to borrow and therefore have made less? However, if the deferred-return investment had paid 4.5 percent instead of 4 percent, at the end of 20 years he would have made $0.21 more interest for each dollar than at 4 percent, which might well have tipped the balance in favor of the deferred-payment investment.

[1] H. H. Chapman, *Forest Finance*, p. 90, J. B. Lyon and Company, Albany, New York, 1927.

2. CONCEPTS OF INTEREST

Three complementary concepts of interest are helpful in understanding its practical aspects. They may be called the "flow," the "reward for waiting," and the "accounting" concepts.

The first is that interest *flows* from the productive use of money. A man hires a house at $60 a month. At the end of the first day's occupancy he has had $2.00 worth of use; at the end of the first hour, $0.0833 worth; at the end of the first minute, $0.00639 worth. If the owner puts his rent into a savings bank, the bank's use starts the moment the teller drops it into the cash box. It is immediately put to work, earning more money both for the owner and the bank. In other words, the owner, the tenant, the bank, and those to whom the bank lends, all get a continuous *flow* of interest or service from this $60. The flow continues as long as the money remains at interest. If we consider the bank as occupying the position of a tank to an intake and outlet pipe, the burning of the house is equivalent to a break in the intake. If the owner withdraws his savings, the outlet is opened. If he lets his interest remain in the bank, the level in the tank rises at a *compound* rate. If he withdraws part of it, the rise is slowed down. If he withdraws all as it earned, the tank level remains constant. In a deferred-payment investment, the flow into the tank is constant, but until the investment matures the outlet is not reached so that the flow cannot be tapped. The magnitude to which the flow mounts if not tapped is indicated by the fact that $1.00 at 4 percent becomes $2549 in 200 years. For short periods and small sums the flow is too small to draw off. The interest on $1.00 at 4 percent for 24 hours has no significance, but on large sums it becomes important; a million dollars will earn over $100 a day at 4 percent.

The economic concept is that "interest is the reward for waiting" or, in highbrow language, "the measure of time preference for future over present goods or money." After the last quotation an example may be necessary. A father leaves his two sons a forest old enough for pulpwood, but which will not be ready for lumber for 15 years. One son immediately sells his half to a pulpmill for $500. The other holds his share for 15 years and sells it at $1000 for lumber. His added $500, turned into interest (Sec. 8*C*), represents his "reward for waiting" and measures his "time preference." Waiting for returns at compound interest amounts to total abstinence, but waiting for simple interest payable at short intervals amounts only to temperance. It is therefore logical that the total abstainer expects the higher reward (Sec. 2).

Society is divided into two classes: those who are willing to wait and those who are not. If too few wait, the accumulation of capital and the development of productive enterprise is almost impossible (Chapt. IV, Sec. 2). If too many wait, current expenditures fall to low levels, factories close, and depression follows. The desire of people to wait or to consume immediately is affected by the interest rate prevailing at different times and places and, in turn, the desire affects the prevailing rate (Sec. 10).

The accounting concept has been so succinctly expressed by Hulvey[1] that we cannot do better than quote him.

> In the proper conception of interest there is no such thing as idle money. If a person places his money in a strong box, he does not receive any returns for its use, but he is actually losing, by reason of his action, a sum equivalent to that which the money would have earned had it been kept active in trade. Interest, therefore, must be accounted for in finance problems regardless of whether the possessor is receiving interest or allowing the money to remain idle.

We made use of this concept in Section 1 and will go into it more fully in Section 9.

3. THE NATURE AND USES OF DISCOUNT

The word "discount," used in such phrases as "sold at a discount," has no relation to its use as a form of interest, nor is the definition "discount is interest collected in advance" accurate although it describes a type of transaction in which a form of discount, called bank discount, is used. *True discounting is a process of determining the amount of money which, if put at interest now at a specified rate, will yield a definite sum at a certain date in the future. In other words, it is interest figured backward from a future to a present date.*

A lumberman sells $10,000 worth of lumber on 2-year credit but cannot wait that long for his pay. A bank or individual, willing to advance it, calculates a sum which, if put at interest for 2 years at a certain interest rate, will equal $10,000, and immediately pays it to him. At 5 percent, this would be $9070. At the end of the 2 years the lumberman pays $10,000 to the lender, who makes a profit of $930 which represents interest on the loan. In other words, $9070 is the *present* or *discounted* value of $10,000, due in 2 years at 5 percent, and $930 is the discount. Discount transactions of this general nature are as common in business as those involving ordinary interest al-

[1] C. N. Hulvey, *The Mathematics of Finance*, p. 1, The Macmillan Company, New York, 1934. Quoted by permission of author and publisher.

though the average person has little contact with them. Discount procedures are also almost as important, in long-term aspects of forestry, as interest in its usual form.

If there are two kinds of interest, simple and compound, there are three kinds of discount, *bank, simple,* and *compound.* Bank discount is determined by subtracting the amount of interest which the full loan would bear if at interest. This results in payment of more interest and hence a higher rate of interest than true discount, which may be either simple or compound. Nevertheless, it is commonly used by banks in discounting small short-term loans. A loan discounted at bank discount is an example of interest paid in advance.

Simple discount is analogous to simple interest in that it is always figured from the original sum, that is to say, if $100 is discounted for 3 years, the discount is always figured from the original $100, multiplying the discount rate by the number of years, whereas in compound discount it is always figured from the discounted value of the previous year. The relation between the three kinds of discount is illustrated graphically in Fig. 3. It is evident from it that bank discount is most favorable to the lender and simple discount the least so.

Although both bank and simple discount are used in ordinary business transactions of forest enterprises, the long-range aspects of forest finance deal exclusively with compound discount.[1] It is used chiefly in forestry to compare the relative financial advantages of deferred-return investments by determining their respective values at maturity, discounting them to the present, and observing their present value. A pulp company is undecided whether to buy an immature stand of pine that is expected to be worth $50,000 in 10 years or a still younger one that is expected to be worth $70,000 in 15 years. If they consider money to be worth 4 percent, they discover that the present value of the young tract is about $5000 more than the older one and, therefore, presumably the better buy.

Neither the reasoning nor the procedure above may be quite clear at this point because both involve an understanding of the mathematical relationship between compound interest and compound discount which is discussed in the next section.

4. RELATION OF DISCOUNT TO INTEREST

If the compound interest on a given sum is calculated for a number of years and added to the principal, and if the total is discounted at

[1] Unless otherwise stated the word discount will hereafter refer to compound discount.

the same rate for the same number of years, it will equal the original sum. Conversely, if a given sum is discounted and the discounted value is put at interest for the same number of years at the same rate, it will equal the original sum.

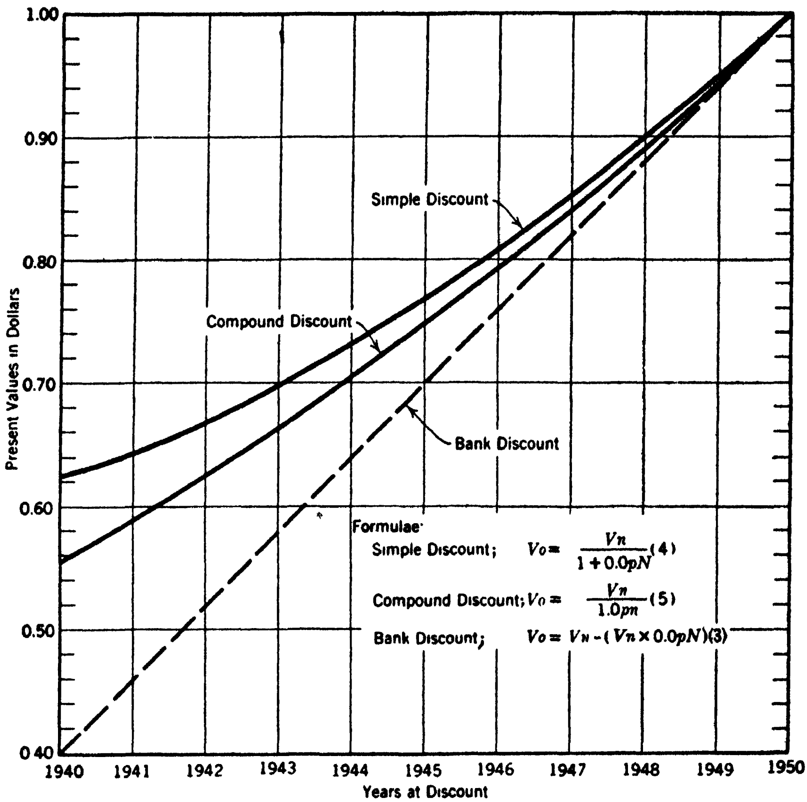

FIG. 3. Simple, compound, and bank discount compared. Present value of \$1.00 at 6%, discounted by each of the three methods from 1950 back to 1940. The actual discount for any year by any of the methods is the difference between \$1.00 and the value on their respective curves.

These relations are illustrated in Fig. 4, where it is seen in Curve 1 that \$1.00 at 4 percent in 12 years increases to \$1.60 and that sum, discounted at 4 percent for 12 years, amounts to \$1.00. Curve 2 shows that \$1.00, discounted for 12 years, has a present value of \$0.625 which, at interest of 4 percent for 12 years, again amounts to \$1.00. In other words, a discount curve is also an interest curve if read backward, as evidenced in Curve 2 where the scale in years is reversed. The difference in form of Curves 1 and 2 is due simply to the fact that Curve 1 is for a higher set of values, which causes it to

rise more sharply (compare with Fig. 2). If Curve 2 were moved to the left until both the dollar points were joined, there would be an interest curve running forward in time for 24 years, showing an increase in value of \$0.625 to \$1.60, and a discount curve running back-

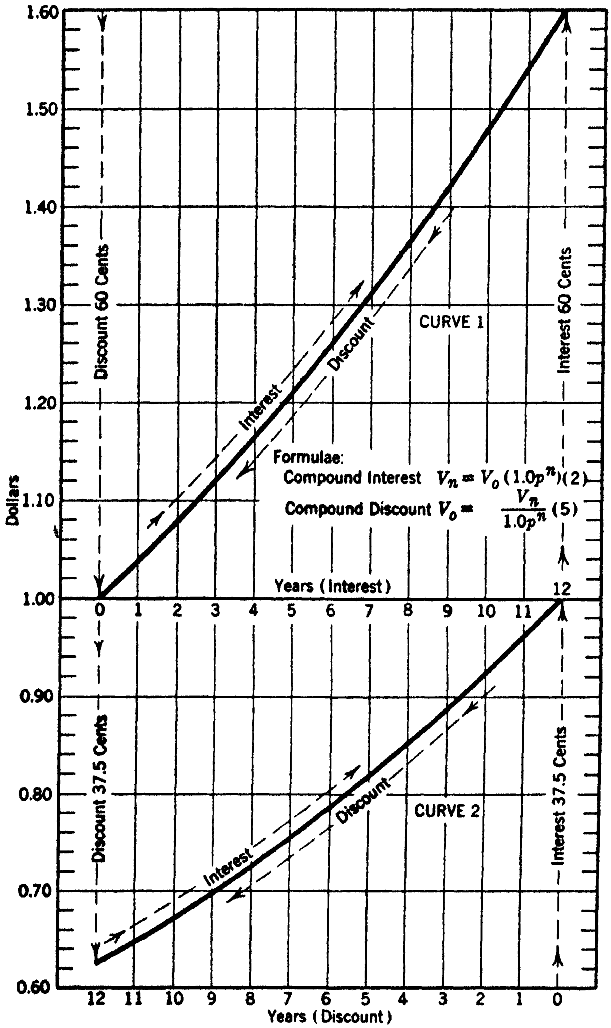

FIG. 4. Relation between compound interest and compound discount. Curve 1 shows that the compound interest on \$1.00 for 12 years at 4% amounts to \$0.60. The sum of interest and principal is \$1.60. This amount, discounted for 12 years at 4%, has a present value of \$1.00. The discount itself is \$0.60. Curve 2 shows that the compound discount on \$1.00 for 12 years at 4% amounts to \$0.375, the discounted value of the \$1.00 being \$0.625. If this sum is put at compound interest at 4% for 12 years, the interest is \$0.375 and the interest added to the principal of \$0.625 again amounts to \$1.00.

ward, showing a decrease of value of \$1.60 in 24 years to \$0.625. With these relationships in mind, it is easy to see how one can translate present into future and future into present values by the use of compound interest and discount.

Certain other important relations between interest and discount are shown in Table 1: (1) Compound-discount values fall more rapidly as the time and interest rate are increased (just as compound interest mounts with rising rapidity with the increase in time and rate). (2) At certain discount rates a larger sum discounted for a longer period has a lower present value than a smaller one discounted for a shorter period. (3) The higher the rate, the greater is the effect of lengthening the time interval. At 1 percent the present value of \$400, due 100 years hence, is nearly twice that of \$100 due 25 years hence. At 3 percent it is less than half as much. At 10 percent it is only $\frac{1}{307}$th as much. (4) The rather more even relations at 3 percent are among the reasons why it is used generally for theoretical calculations involving discount (Chapt. XIII, Sec. 7).

TABLE 1

EFFECT OF INCREASE IN LENGTH OF DISCOUNT PERIOD COMBINED WITH INCREASE IN SIZE OF SUMS DISCOUNTED

Discount Rate	\$100 for 25 Years	\$200 for 50 Years	\$300 for 75 Years	\$400 for 100 Years
1	\$77.98	\$121.60	\$142.26	\$147.88
1.5	68.92	95.00	97.22	90.24
2	60.95	64.30	67.95	54.40
2.5	53.94	58.18	47.07	33.84
3	47.76	45.62	32.67	20.80
4	37.51	28.14	15.84	7.92
5	29.53	17.44	8.21	3.04
6	23.30	10.86	3.78	1.16
7	18.42	6.78	1.86	0.44
8	14.60	4.26	0.93	0.20
9	11.60	2.68	0.48	0.08
10	9.22	1.70	0.24	0.03

5. THE THEORY OF DISCOUNT

Chapman[1] says, "A hungry man sets a proportionately higher value on today's meal than on one promised him next week." By add-

[1] Chapman, *op. cit.*, p. 38.

ing the further statement that any one who is really hungry would rather have a sandwich at once than a full meal the next day or a banquet next month, one arrives at the theory of discount. *To the one who needs money, a smaller sum is more valuable immediately than a larger one at a future date; and the more remote the date, the less value he attaches to it.* To a beggar what is a dime which he is to get a year from next July? The lumberman who has the wholesale lumber dealer's note, discounted at 4 percent, would rather lose the 4 percent for the sake of having the 96 percent immediately. If interest is considered by the recipient as his reward for waiting (Sec. 3), discounting is a transaction in which one party pays a penalty for not waiting. The flow concept for interest, also described in Section 3, is also applicable to discount. The only difference is that the discount flow is backward from the future to the present instead of forward from the present to the future.

Abstractly considered, interest also flows from the future back to the present since the value of capital is derived from the goods and services it is expected to produce in the future[1] (Chapt. IV, Sec. 6). Expanding this idea, discount is itself the fundamental form of interest, an ordinary interest payment being nothing but a special form of discount. It is of more practical importance to remember that discounting always involves determination of a present value for something not yet in existence or for which the complete value cannot yet be realized. A discount transaction is an expression of faith in the future.

6. THE NATURE AND USES OF ANNUITIES

A sum, added to at equal intervals by equal sums, all bearing the same rate of compound interest, is known mathematically as an *annuity*.[2] This form of progression has many uses in business and finance. A father, having a 5-year-old son, wishes to deposit an equal sum annually in a savings bank paying 3 percent, so that the boy will have $2000 when he enters college at the age of 18. How much must he deposit annually? What will be the total taxes and interest on a forest plantation maturing in 35 years if the taxes are $0.25 per acre per annum and the money is borrowed at 3.5 percent?

An annuity progression obviously involves both addition and multiplication. The cash payments are added progressively; the interest

[1] Irving Fisher, *The Theory of Interest*, The Macmillan Company, New York, 1930.

[2] Insurance payments in annual form to a recipient are also called annuities, but we are not concerned with their mathematical principles even though they are derived from the fundamental annuity equation.

multiplies on each payment individually. Each payment, starting from the initial one, draws interest for one year less than the previous one. The last payment in an ordinary annuity draws no interest, since it is made at the time the annuity is terminated.[1] Figure 5 is a graphic

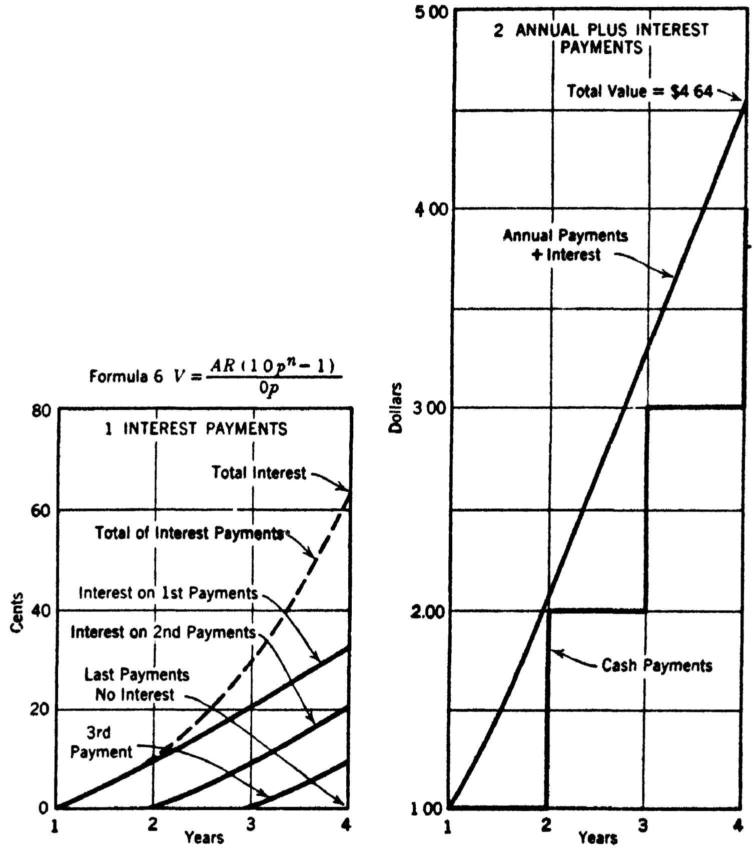

FIG. 5. Analysis of interest and cash payment on an ordinary annuity of $1.00 at 10% for 4 years. The left-hand chart shows the accruing interest on each individual cash payment and the total of accrued interest for all cash payments by years. The right-hand chart shows the annual cash payments in relation to the accruing interest. Note the increasing importance of interest, as compared with cash payments, as the years go by.

analysis of an ordinary annuity which should make this clear.

The following expressions are used in dealing with annuities. The *amount* is the total of all cash payments plus interest. The *term* of

[1] In a so-called annuity due, the last payment is assumed to have been made at the beginning of an interest period and therefore bears interest for the last year also. We are here concerned only with ordinary annuities.

an annuity is the number of years it runs. The cash payment is known as the *rent*. If these payments are other than annual, the rent is called *periodic*. The time between payments is known as the *period*. Even though the annual rent of an annuity is small, its amount becomes large if the rate is high and the period long. An annuity of $1.00 at 7 percent will yield $8824.28 in a century.

If the amount of an annuity is discounted to the present, its present value will be a sum which, if left at compound interest at the same rate for the same term as the annuity, will amount to the same sum (Secs. 3 and 8*E*).

7. INTEREST AND DISCOUNT AS MEASURING STICKS

Both interest and discount not only figure as profit or expense items in business operations but also are used as measuring sticks to contrast the financial advantages of prospective business courses, the relative profit of different investments, and the comparative cost of different industrial processes. In fact, it is impossible to make financial calculations dealing with the future without making use of interest and discount. So used, they are among the most valuable of tools for analysis of forestry problems of an economic nature. Their main purposes and methods are discussed under the following subheadings.

A. Interest and Discount Used To Determine Carrying Charges. As we explained in Section 1, carrying charges on deferred-payment investments accumulate at compound interest. The prospective investor can estimate the cash costs for each year and by figuring them at compound interest determine approximately how much the investment will cost him at maturity.

Suppose that he can buy immature timberland at $30 per acre and that the taxes, fire protection, and so on are estimated at $0.50 per acre per annum. If he borrows the money at 3.5 percent, what will the property have cost him 15 years hence when the timber is mature? Obviously, he pays compound interest on an original investment of $30 per acre for 15 years, plus compound interest on an annuity of $0.50 per annum. The actual cash carrying charges amount to $29.91, but the total cost per acre at maturity is $59.91—practically double his original investment. Suppose that he had a chance to buy other land at a lower cost and that the annual taxes on it will be less but the timber will not mature for 20 years. By running the same calculation, he can easily determine which tract has the lower carrying charges, and thus get a clue to which is the better buy. By use

of discount he can compare their present value, as mentioned in Section 3 and discussed more fully in Section 7*B*.

B. Interest and Discount As a Means of Determining Value. (See Chapt. VIII, Sec. 1, for definition of value.) In the last analysis, the monetary value of a business, a piece of property, or an investment depends upon the profit it will yield or upon what is called its *earning power*. If its net annual income can be determined, that sum can then be considered as the interest and the value of the property determined from it. A man owns a small house which he rents. His net return is $100 per year. This represents the profit on his investment. One may assume that this represents any rate of interest one chooses, but in practice it would be necessary to use the common rate used in the community, say, 5 percent. By determining the sum which at 5 percent will yield $100 per year, namely, $2000, one has valued the house in terms of its earning power. This is called its *capital value*.[1]

Observe that, if a different rate of interest is used, the value of the property changes. If 4 percent had been used, its value would have been $2500; at 6 percent, $1666.66; which is another way of pointing out that the use of interest rates to determine value is only valid when the rate used corresponds to the rate current at the time and place (Sec. 9). And the lower the rate, the more the property appears to be worth. This is logical if one remembers that it takes more money to yield a certain amount of interest at a lower rate than at a higher one.

It may be observed further that the house may have cost $5000 or only $1500. If it cost $5000, either the owner paid too much to the builder or he is not getting enough rent; if it cost $1500, perhaps he drove a hard bargain with the builder or is overcharging the tenant. Or perhaps the value of money has decreased or increased since the house was built (Chapt. VII, Sec. 3). However, none of these reasons alters the fact that, if the owner and his tenant want to get together on a sale, they ought to reach a figure in the neighborhood of $2000 if the current rate of interest is 5 percent. The same principle may be used in valuing a forest property yielding a known income, as a woodlot from which the farmer can take a number of cords per year equivalent to annual growth.

When dealing with a deferred-payment investment (Secs. 3 and 4), value is determined by discounting their profit at maturity to the present. Both methods are in daily use in business and finance. Im-

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[1] Also called *capitalized, capitalized income, expectation, discount,* and *present value* (Chapt. VIII, Sec. 1*B*; see also Chapt. VI, Sec. 8*I*).

portant uses in forestry are detailed in later chapters, notably Chapter XIII, Section 6, and Chapter XVIII, Sections 4 to 9. As is demonstrated in Section 8*I* of this chapter, both methods are really a discounting procedure.

C. Interest Used To Determine a Rate of Profit. In business and investment a certain sum of money is made on a certain expenditure of capital. The relation of one to the other is expressed by the interest on its use. It may also be used as a measure of comparative profit from different expenditures. A man operated two small sawmills for a year. The fixed and operating cost of one was \$1500; the other, \$2000. The net profit on the first one was \$250; that on the second, \$375. Which was the more profitable in terms of percentages earned on capital invested? By dividing 1500 into 250 it is discovered that the interest rate made by Mill 1 was 16.66 percent and, by the same sort of calculation, that the interest rate of Mill 2 was 18.75 percent. Evidently his added capital expenditure of \$500 on Mill 2 increased his rate of profit, but it does not always follow that added capital expenditures necessarily result in increased profit rates (Chapt. VIII, Sec. 2*C*).

This sort of calculation also can be made for investments maturing in the future, but it requires the use of compound interest and is considered in Section 8*J*. The use of discount to compare profits from such investments has already been discussed (Sec. 3).

8. THE COMPUTATION OF INTEREST AND DISCOUNT

All problems involving interest and discount may be solved arithmetically, but when compound interest and discount are involved, arithmetical solution is very time-consuming. It can be avoided by the use of a combination of algebraic formulae and tables, giving values which are substituted in the formulae. Calculation then becomes speedy and simple. Interest may also be calculated by logarithms, but solution by use of interest tables is generally simpler and quicker. The basic interest and discount formulae are introduced in this section. They are common to all aspects of mathematical finance. Not only are they used in the simpler calculations of forest finance, but from them also are derived others used in more complicated problems. They are introduced later in the text.

In using any one of these formulae, it never must be forgotten that they are like computing machines, they handle correctly the figures fed into them but assume no responsibility for accuracy of the figures themselves. Since no one knows the future, only by chance can the

figures used in the formulae be accurate. Certain types of mind which enjoy the precision of mathematics tend to forget this fact and treat the calculations of forest finance as final criteria. Others, realizing that they cannot be so regarded, go to the other extreme and reject them utterly. Neither attitude is realistic. If one remembers that approximate figures show trends, their usefulness as one of the tools for the analysis of the intricate and important economic problems of forestry is apparent.

A. Symbols Used in Interest Formulae. In literature of forest and mathematical finance, one encounters rather different-looking formulae merely because of the use of different symbols. The following list, used in this text, follows closely that used by Chapman in his *Forest Finance*, and is as near standard as any used in forestry texts.

N	Number of years a sum of money is at *simple interest* or *simple discount*.
n	Number of years a sum of money is at *compound interest* or *compound discount*.
V	Value of a sum of money.
V_0	In a compound-interest formula, V_0 indicates the value of a sum at the time it is put at interest. In a compound-discount formula, it indicates the value of the sum after it has been discounted.[1]
V_n	In a compound-interest formula, V_n indicates the value of a sum after it has been at interest for n years; in a compound-discount formula, it indicates the value of the sum to be discounted.[1]
V_1, V_2, etc.	Are substituted for V_n according to the actual number of years involved. Thus, if a sum V is at interest for 30 years, it is written V_{30}.
V^{n-1}, V^{n-2}, etc.	Indicate the values of V_0 at interest for 1, 2, or more years less than V_n.
$0.0p$	The rate of simple interest or discount, the actual rate being substituted in the solution of the formula.
$1.0p$	Principal plus interest on \$1.00 (or other curreney) for 1 year. Thus, if the interest rate is 5%, the value of \$1.00 at the end of a year is \$1.05.
$1.0p^n$	Principal plus interest at *compound interest* on \$1.00 for n years. Thus, 1.045^{25} indicates the value of \$1.00 at 4.5% compound interest at the end of 25 years.

[1] It is evident that, in interest, formulae V_n is the x of the equation; whereas, in a discount formula, V_0 is the x.

$1.0p^n - 1$	The amount of interest at *compound interest* at the end of n years. Thus, if the interest rate is 4% and is to run for 30 years, it is written $1.04^{30} - 1$.
$1.0p^{n-1,\ n-2}$, etc.	Indicates principal plus interest at compound interest for 1, 2, or more years less than n years.
R	A rental, annual or periodic (Sec. 6).
AR	An annual rental.
PR	A periodic rental.
m	The period in years between periodic rentals.

Certain special symbols are introduced and explained in some of the special formulae.

B. Interest and Discount Formulae. The first ten basic formulae are introduced in this chapter; the others, in later chapters.

Formula 1—*Simple Interest* [Sec. 8*C*]

$$V_n = V_0 + (V_0 \times 0.0pN)$$

Formula 2—*Compound Interest* [Sec. 8*D*]

(Future value of a present sum.)

$$V_n = V_0(1.0p^n)$$

Formula 3—*Bank Discount* [Sec. 8*E*]

$$V_0 = V_n - (V_n \times 0.0pN)$$

Formula 4—*Simple Discount* [Sec. 8*F*]

$$V_0 = \frac{V_n}{1 + (0.0pN)}$$

Formula 5—*Compound Discount* [Sec. 8*F*]

(Present or discounted value of a future sum.)

$$V_0 = \frac{V_n}{1.0p^n}$$

Formula 6—*Annuity* [Sec. 8*G*]

(Future value of a sum which is added to annually by equal sums, all bearing interest.)

$$V_n = \frac{AR(1.0p^n - 1)}{0.0p}$$

Formula 7—*Annuity at Discount* [Sec. 8*H*]

(Present value of a future series of equal annual payments at compound interest.)

$$V_0 = \frac{AR(1.0p^n - 1)}{0.0p \times 1.0p^n}$$

Formula 8—*Capital Value of an Annual Rental* [Sec. 8*I*]

$$V_0 = \frac{AR}{0.0p}$$

Formula 9—*Rate of Profit on an Investment Paying an Annual Income* [Sec. 8*J*]

$$0.0p = \frac{AR}{V_0}$$

Formula 10—*Rate of Profit on an Investment Maturing in the Future* [Sec. 8*J*]

$$1.0p^n = \frac{V_n}{V_0}$$

Formula 11—*Annual Payment on a Sinking Fund* [Chapt. VII, Sec. 6]

$$AR = \frac{V_n}{\dfrac{1.0p^n - 1}{0.0p}} \quad \text{or} \quad \frac{V_n(0.0p)}{1.0p^n - 1}$$

Formula 12—*Present Value of a Terminating Series of Periodic Rentals* [Chapt. XIII, Sec. 6*A*]

$$V_0 = \frac{PR(1.0p^{mn} - 1)}{(1.0p^m - 1)1.0p^{mn}}$$

Formula 13—*Present Value of an Infinite Series of Periodic Payments* [Chapt. XIII, Sec. 6*A*]

$$V_0 = \frac{PR}{(1.0p)^m - 1}$$

Formula 14—*Gross Cost of Producing a Stand of Timber* [Chapt. XIV, Sec. 10*A*]

$$GC = II(1.0p^n) + \frac{AR(1.0p^n - 1)}{0.0p} - (L + I)$$

Formula 15—*Net Cost of Producing a Stand of Timber* [Chapt. XIV, Sec. 10*B*]

$$NC = II(1.0p^n) + \frac{AR(1.0p^n - 1)}{0.0p} - T(1.0p)^{n-t} - (L + I)$$

Formula 16—*Sum of Irregular Tax Increases* [Chapt. XVII, Sec. 6]

$$V_n = \frac{AR_1(1.0p^n - 1)}{0.0p} + \frac{AR_2 - AR_1(1.0p^{n-a} - 1)}{0.0p} + \frac{AR_3 - AR_2(1.0p^{n-b} - 1)}{0.0p} + \cdots$$

Formula 17—*Future Value of an Arithmetical Series* [Chapt. XVII, Sec. 6]

$$V_n = \frac{a\ 1.0p^n - n(0.0p) - 1}{0.0p^2}$$

Formula 18—*Sum of Taxes When Annual Tax Is Lowered Irregularly* [Chapt. XVII, Sec. 6]

$$V_n = \frac{AR_1(1.0p^{n-a} - 1)1.0p^a}{0.0p} + \frac{AR_2(1.0p^{a-b} - 1)1.0p^b}{0.0p} + \cdots \frac{AR_X(1.0p^x - 1)}{0.0p}$$

Formula 19—*Sum of a Decreasing Arithmetical Series* [Chapt. XVII, Sec. 6]

$$V_n = \frac{T}{n}\,\frac{1.0p^n[n(0.0p) - 1] + 1}{0.0p^2}$$

C. Simple Interest. The computing of simple interest is so easy that the use of formulae and tables are scarcely necessary. The formulae are introduced, however, to facilitate the understanding of the more complex calculations of compound interest.

Problem. To find the sum of the interest and the principal for a series of years.

Method. Determine the interest for 1 year; multiply by the number of years and add the result to the principal.

Formula. $V_n = V_0 + (V_0 \times 0.0pN)$ [*Formula 1—Simple Interest*]

Solution. Let $V_0 = \$100$

$0.0p = 5\%$

$N = 5$ years

Then

$$Vn = 100 + (100 \times 0.05 \times 5)$$

$$Vn = 100 + (100 \times 0.25)$$

$$Vn = 100 + 25 = \$125$$

Remarks. If we wish to know only the interest, we do not need to add the principal.

D. Compound Interest. Compound interest may be calculated by the simple but laborious process of figuring the simple interest for the first year, adding it to the principal, figuring the interest on both for the second year, and so on. We can write this process algebraically in this fashion:

$$V_0 \times 1.0p = V_1$$

$$V_1 \times 1.0p = V_2$$

$$V_2 \times 1.0p = V_3$$

Example. Let $V_0 = \$100$

$1.0p = 5\%$

$V_n = 3$ years

Then

$\$100 \times 1.05 = \$105$, interest and principal at end of 1st year

$\$105 \times 1.05 = \$110.25$ interest and principal at end of 2nd year

$\$110\ 25 \times 1.05 = \$115.7625$, interest and principal at end of 3rd year, etc.

This can be expressed as a sort of omnibus formula as follows:

$$V_n = V_0 \ (1.0p \times 1.0p \times 1.0p \ldots \text{to the } n\text{th year})$$

It will be noted in the above that the constant $1.0p$ is multiplied by a new quantity each time, or that the constant $1.0p$ is multiplied by itself the necessary number of times and then by V_0. Remembering that the expression $1.0p$ is the equivalent of the interest and principal of $1.00 for one year, it is evident that, if we know the compounded interest on $1.00 for every year and every percentage, we can simply multiply it by the number of dollars in the original principal.

Using the expression $1.0p^n$, we can write the formula for compound interest thus:

$$V_n = V_0 \ (1.0p^n) \quad [\textit{Formula 2—Compound Interest}]$$ [1]

This formula, in itself, is no great help in calculating compound interest since it is almost as laborious to calculate the interest for a series of years on $1.00 and then multiply by the original principal as to calculate the interest for each year on the whole principal. It is seldom necessary to calculate either way because tables which give the interest for principal for $1.00 at compound interest, at all ordinary percentages and for long series of years, are easily obtained. These tables are called variously "compound interest tables," "tables of $1.0p^n$," "tables of the value of 1 at compound interest," or simply "tables of n."[2] By substituting the appropriate values from Column 1 of the interest table in the Appendix in *Formula 2* its solution is a matter of a single multiplication.

Problem. To find the compound interest on $600 for 15 years at 6%.

Formula. $V_n = V_0(1.0p^n)$ [*Formula 2—Compound Interest*]

Solution. $V_n = \$600 \times (1.06^{15})$ The tabular value of 1.06^{15} is 2.3966.

Substitute. $V_n = \$600 \times 2.3966 = \$1437.96$

Remarks. To determine the interest only, subtract the original principal.

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[1] Many mathematical finance texts write this formula $S = (1 + i)^n$.

[2] Such tables are carried out from three to ten decimal places. For small sums and short periods three places suffice. For large sums and long periods four places should be employed. In dealing with special problems still more are needed. Four places generally have been used for solutions in this text.

Formula 2 is the basic formula for all calculations in both compound interest and discount. All the others are derived from it.

E. Bank Discount. Bank discounting was referred to in Section 3 as a process of discounting a loan by subtracting interest from principal.

Problem. To find the present value of a sum at bank discount.

Method. Find the amount of interest the principal would bear for the same length of time it is to be discounted, and subtract from the principal.

Formula. $V_0 = V_n - (V_n \times 0.0pN)$ *[Formula 3—Bank Discount]*

Example. Find the bank discount on a loan of $200 for 2 years at 5%.

Solution. $V_n = 200; N = 2; 0.0p = 0.05$

Substitute.
$$\begin{aligned} V_0 &= 200 - (200 \times 0.05 \times 2) \\ &= 200 - (200 \times 0.10) \\ &= 200 - 20 = \$180 \end{aligned}$$

Remarks. The discount itself obviously amounts to $20.

The inaccuracy of bank discount is shown by assuming that a man borrows $100 for 1 year from a bank at 5 percent. The bank discounts this loan by subtracting the $5.00 interest and handing him $95, expecting him to return $100. Obviously, he has had the use of only $95, but is paying for the use of $100. The simple interest on $5.00 at 5 percent for 1 year amounts to $0.25. Therefore the bank is receiving an extra profit of $0.25, to which it is not strictly entitled. Figured by true discount, the borrower would receive $95.24. The $0.25 amounts to the interest on the $5.00 which the lender held back and on which, theoretically, the borrower should not have had to pay interest. In small loans perhaps such differences are unimportant, but, if the loan had been for $100,000, this $0.24 would become $240.

F. Simple and Compound Discount. The definition of true discounting is "the process of determining the amount of money which, if put at interest now at a specified rate, will yield a definite sum at a certain date in the future." If this sum is put at interest at the same rate and for the same time, it will equal the original sum. This is the same thing as saying that, *if one divides one sum by another and then multiplies them together, he gets the original sum.* Therefore true discount is determined by a division process which is expressed by the equation $V_0 = V_n/1.0p$. This equation holds good for 1 year at both simple and compound discount, for, like simple and compound interest,

the values are the same. It has to be modified, however, for longer periods.

Problem. Find the discount (present) value of $100 for 1 year with discount at 5%.

Method. Divide the sum to be discounted by the same sum with interest added.

Formula. $V_0 = \dfrac{V_n}{1.0p}$

Solution. $V_0 = \dfrac{100}{1.05} = \$95.23801$

Remarks. The actual discount is, of course, $V_n - V_0 = \$4.76$

Proof. Find the sum of interest and principal on $95.23801 for 1 year at 5%.

Formula. $V_n = V_0 - (V_0 \times 0.0pN)$ *[Formula 1—Interest]*

Solution. $V_n = 95.23801 + (95.23801 \times 0.05) = \$100.00$

Although the general formula $V_0 = V_n/1.0p$ holds for one year at both simple and compound discount, it must be modified for longer intervals for each discount. This is easy because discounting is a process of dividing a sum which represents interest plus principal into one which represents principal only. It is necessary only to write the formula for either simple or compound interest as a divisor. Thus the simple-discount formula becomes $V_0 = V_n/1 + 0.0pN$, and the compound discount formula becomes $V_0 = V_n/1.0p^n$. Each will be discussed in turn.

1. Simple Discount

Problem. Find the present value of $100 discounted for 3 years at 5%.

Formula. $V_0 = \dfrac{V_n}{1 + (0.0p \times N)}$ *[Formula 4—Simple Discount]*

Solution. $V_0 = \dfrac{100}{1 + (3 \times 0.05)} = \dfrac{100}{1.15} = \$86.95$

Remarks. Discount equals $V_n - V_0 = \$13.05$

2. Compound Discount

Problem. Find the present value of $200 discounted for 3 years at 5%.

Formula. $V_0 = \dfrac{V_n}{1.0p^n}$ *[Formula 5—Compound Discount]* [1]

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[1] This formula is often written in texts on mathematical finance as $V_n = (1 + i)^{-n}$. The $-n$ is a negative exponent meaning "divided by."

There are several methods of solving this formula.

Method 1. Determine the discount for each year from that of the previous year, using the simple discount formula $V_0 = V_n/1 + 0.0p$ (Formula 4) for each calculation, but apply it to the discounted value of the previous year.

Example Find the present value of \$300 at compound discount for 3 years at 5%.

Solution. First year: $V_1 = \dfrac{V_n}{1 + 0.0p} = \dfrac{300}{1.05} = 285.71$

Second year: $V_2 = \dfrac{V_1}{1 + 0.0p} = \dfrac{285.71}{1.05} = 272.10$

Third year: $V_3 = \dfrac{V_2}{1 + 0.0p} = \dfrac{272.10}{1.05} = 259.14$

Method 2. Determine the value of $1.0p^n$ for the proper rate and year from Column 1 of the interest table, and divide into V_n.

Example. Using the same figures as in Method 1, the value of $1.0p^3$ at 5%, taken from the table, is 1.1576.

Substitute. $V_0 = \dfrac{V_n}{1.0p^n} = \dfrac{300}{1.05^3} = \dfrac{300}{1.1576} = \$259.14$

Method 3. Determine the discounted value of \$1.00 and multiply by V_n.

Example. Using the same figures as in Method 1, we first solve Formula 5, $V_0 = V_n/1.0p^n$, for 1, as follows:

$$V_0 = \frac{1}{1.05^3} = \frac{1}{1.1576} = 0.8638 \times 300 = \$259.14$$

A formula for this procedure is

$$V_0 = V_n\left(\frac{1}{1.0p^n}\right)$$

Discount tables giving values for \$1.00, made from the above formula for a series of rates and years, are commonly used for discount problems. They are called discount tables or "tables of the present value of 1." (See Column 2 of the interest tables in the Appendix.) If this kind of table is not available, the easiest solution of a discount problem is by Method 2, with the use of an ordinary $1.0p^n$ table (Column 1).

G. Annuities. Bear in mind what was said in Section 6 and shown graphically in Fig. 4. An omnibus formula for an annuity, then, can be written as follows:

$$V_n = AR(1.0p)^{n-1} + AR(1.0p)^{n-2} \cdots + AR(1.0p) + AR$$

Let us take a short period and figure an annuity with a rental of $50 per annum for 4 years at 4 percent from this formula. By substitution we get

$$V_n = 50(1.04)^3 + 50(1.04)^2 + 50(1.04) + 50$$

From Column 1 interest table in Appendix

$$V_n = 50(1.1249) + 50(1.0816) + 50(1.04) + 50$$
$$V_n = 56.24 + 54.08 + 52 + 50 = \$212.32$$

This is an exceedingly slow method of computation, but by algebraic manipulation this omnibus formula consolidates into a form which allows for easy solution, as follows: [1]

Formula. $V_n = \dfrac{AR(1.0p^n - 1)}{0.0p}$ *[Formula 6—Annuity]*

Problem. Find the amount of an annual annuity of $50 when the term is 4 years and the interest 4%.

Method 1. Substitute in Formula 6, using Column 1 of the interest table for values of $1.0p^n$.

Solution. $V_n = \dfrac{AR(1.0p^n - 1)}{0.0p} = \dfrac{50(1.1699 - 1)}{0.04} = \dfrac{50(0.1699)}{0.04}$

$= 50(4.2465) = \$212.32$

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[1] The following are the algebraic manipulations for consolidating Formula 5 from the omnibus formula.

$$V_n = AR(1.0p)^{n-1} + AR(1.0p)^{n-2} \cdots + AR(1.0p) + AR$$

Step 1. Let AR equal 1, then

$$V_n = (1.0p)^{n-1} + (1.0p)^{n-2} \cdots + 1.0p + 1$$

Step 2. Multiply both sides of the equation by $1.0p$.

$$V_n(1.0p) = (1.0p)^n + (1.0p)^{n-1} \cdots + 1.0p$$

Step 3. Subtract Step 1 from Step 2.

$$V_n(1.0p) - V_n = (1.0p)^n - 1$$

Step 4. Left-hand side of equation can be written

$$V_n[(1.0p) - 1] = (1.0p)^n - 1$$

Step 5. Subtract in the brackets.

$$V_n(0.0p) = (1.0p)^n - 1$$

Step 6. Divide both sides of the equation by $0.0p$.

$$V_n = \frac{(1.0p)^n - 1}{0.0p}$$

Step 7. In Step 1 we set 1 as a value for AR. Its reintroduction merely multiplies the value of V_n by the same amount and we come out:

$$V_n = \frac{AR(1.0p^n - 1)}{0.0p} \qquad \textit{[Formula 6]}$$

Method 2. Use of annuity tables.[1] Tables for the amount of an annuity of \$1.00 have been constructed by solving Formula 6 for a long series of years and percentages, letting AR equal 1. Column 3 of the interest tables in the Appendix gives these values. When such tables are available, solution is very simple; merely substitute the annual value for rent and multiply \$1.00 by the number of dollars in the annual rent.

Problem. Find the amount of an annuity whose annual rent is \$250 and whose term is 30 years at 4.5%.

Solution. Determine from an annuity table the value of an annuity of \$1.00 for 30 years at 4.5%, which is \$61.0071, and multiply:

$$61.0071 \times 250 = \$15{,}251.78$$

H. The Present Value of an Annuity. The present value of an annuity can be determined by the compound-discount formula (Formula 5), $V_0 = V_n/1.0p^n$, just as for another future sum. However, it is possible to determine it without first determining its amount by inserting the discount factor $1/1.0p^n$ as one of the divisors in Formula 6, thus, automatically bringing the discounting processes into play.

Thus the formula for discounting an annuity becomes

$$V_0 = \frac{AR(1.0p^n - 1)}{0.0p \times 1.0p^n} \quad \textit{[Formula 7—Present Value of an Annuity]}$$

Problem. Determine the present value of an annuity whose annual rent is \$50 at 4% and whose term is 4 years.

Method 1. Use Formula 6 to determine the amount, and then determine the present value by Formula 5. Since we determined the amount of such an annuity to be \$212.32 by using Formula 6 in Method 1 (Sec. 8*G*). We can immediately determine its present value by Formula 5, which is \$181.49.

Method 2. Substitute, using values from Column 1 of the interest tables in Formula 7.

Formula.
$$V_0 = \frac{AR(1.0p^n - 1)}{0.0p \times 1.0p^n}$$
$$= \frac{50(1.04^4 - 1)}{0.04 \times 1.04^4} = \frac{50(1.1699 - 1)}{0.04 \times 1.1699} = \frac{50(0.1699)}{0.04679}$$
$$= \frac{8.4950}{0.04679} = \$181.49$$

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[1] Sometimes called "tables of amount of annuity of 1 per period" or tables of $S_{\overline{n|}}$ (read S angle n).

Method 3. Use of annuity discount tables. Tables have been compiled which give the present value of an annuity of $1.00 for a series of percents and years. They are often called "Tables of present value of 1 per annum at compound interest" or "Tables of present value of an annuity of 1 per annum" (Column 4 of the interest tables). Solution by means of them is merely a matter of multiplying the correct figure in the tables by the rent of the annuity.

Problem. Determine by the use of annuity discount tables the present value of an annuity whose annual rent is $50 at 4% when its term is 4 years.

Solution. After determining from annuity discount tables the value of an annuity of the above term and rate, which is 3.6299, multiply by 50, which gives $181.49.

Remarks. Although results of all three methods are the same in dealing with long terms and large sums, if only three-place tables are used slight differences in the last cent will occur when one method is checked against another. In the absence of a table of present value of an annuity, Method 2 is the most satisfactory.

I. Capital Value. It was stated in Section 7*B* that the value of an investment paying an annual rental can be determined by the use of interest; that of one maturing in the future, by the use of discount. The mathematics are simple.

Problem. Determine the capital value of a forest nursery producing an average annual net income of $6500. The interest rate in the region is 3.7%.

Formula $V_0 = \dfrac{AR}{0.0p}$ *[Formula 8—Capital Value of an Annual Rental]*

Solution. $V_0 = \dfrac{6500}{0.037} = \$175{,}675.68$

Remarks. A demonstration of this formula is unnecessary. It is obvious that the annual interest on $175,675.68 amounts to $6500.

With a deferred-income property or investments there are several possible variations, dependent upon whether the income occurs only once or whether it recurs annually or periodically when it finally starts. Where only one future income is concerned—for example, a young stand of timber which is to be cut clear when mature—it is solved by the formula for compound discount, Formula 5, $V_0 = V_n/1.0p^n$. The other cases require more complicated formulae derived from it which are introduced at appropriate places later in the text.

It is a help in understanding capital value to realize that it is always a discounting calculation even though it is referred to above as the

interest method. Formula 8, used in determining the capital value of a series of annual incomes tacitly assumed to be perpetual, is really a discount formula. In using it, the present value of an infinite series of annual rentals is determined.[1]

J. Rate of Interest Made on an Investment. The annual rate of interest made on an investment paying an annual income is obviously expressed by the formula

$$0.0p = \frac{AR}{V_0}$$ *[Formula 9—Rate of Profit on an Investment Paying an Annual Income]*

Problem. Find the rate of interest made on an investment of \$1200 which yields \$300 in dividends per annum.

Solution. $0.0p = \frac{AR}{V_0} = \frac{300}{1200} = 0.25 = 25\%$

An investment maturing in the future involves the use of compound interest. It is evident from the compound-interest formula $V_n = V_0(1.0p^n)$, Formula 2, that if we divide V_0 into V_n, we get $1.0p^n$, or

$$1.0p^n = \frac{V_n}{V_0}$$ *[Formula 10—Rate of Profit on an Investment Maturing in the Future]*

Problem. Find the rate of interest earned on an original investment of \$5000 in timberland which, owing to the increase in stumpage prices plus growth, nets \$6500 when sold at the end of the fifth year.

Solution. Substituting in Formula 10,

$$1.0p^n = 1.0p^5 = \frac{6500}{5000} = 1.3000$$

It is necessary to use $1.0p^n$ tables[2] to determine the rate of interest corresponding to 1.3000. To secure the rate earned from this

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[1] This can be demonstrated mathematically from Formula 12, $V_0 = [PR/(1.0p^n) - 1]$, present value of a series of perpetual periodic rentals (Chapt. XIII, Sec. 6A). If we let the period equal 1 year, the formula reads $V_0 = [AR/(1.0p) - 1] = AR/0.0p$, Formula. Further light is shed on this by the expedient of plotting discount values of \$1.00 for 1 year, \$2.00 for 2 years, \$3.00 for 3 years, etc., for a long series of years. It will be discovered that, although the values increase continually, the rate of increase is always declining and finally becomes imperceptible. Formula 8 sums up all possible increase in value with increase in time.

[2] Column 1, interest tables, Appendix.

figure, search the 5-year lines of a $1.0p^n$ table for the rate corresponding to the value 1.3000. Only by chance does one hit upon an exact rate; but, by using tables giving decimal or fractional percents, an approximate rate, close enough for most purposes, can be found. In this case the two nearest values to 1.3000 are 1.295 equals 5.3% and 1.301 equals 5.4%. Since the latter is the closer, the rate may be taken as 5.4%. If greater accuracy is required, perhaps the simplest method is to interpolate graphically on cross-sectioned paper although it is possible to obtain the exact rate by use of logarithms. It should be remembered that the rate obtained is compound-interest rate.

9. INTEREST IN ACCOUNTING

The accounting concept of interest—namely, that it must be considered in financial transactions whether it represents an actual exchange of cash or not (Sec. 1)—requires some elaboration as to its application. It is obvious that if a man borrows money the interest paid on it represents a cost to the borrower and a receipt to the lender. In this form of transaction it finds its place, without question, in ordinary bookkeeping. If a sum of money is borrowed at 5 percent and the borrower, after paying all his other costs of operation, has increased the amount of money by 10 percent, the first 5 percent must be paid to the lender as the cost of using borrowed capital. The remaining 5 percent represents the borrower's profit on the use of the capital he borrowed. This also affords no bookkeeping difficulties. Payments to the lender are recorded as "interest payments," the remainder going into the borrower's accounts as "profits."

In actual accounts, sums of money rather than rates of interest appear. The rate at which the borrowing is made is fixed by the terms of the loan, but the amount of profit made on its use is not known until the transaction is completed. It can then be turned into a *rate of profit*[1] by the use of Formula 9 or 10 (Sec. 8*J*), depending on whether simple or compound interest is involved. Since the value of capital is changing constantly (Chapt. VII, Sec. 7), the determination of rate of profit is difficult sometimes, even though its mathematics are simple.

Often it is difficult to grasp why interest has to be accounted for when an individual or a corporation invests its own money. How can either pay itself interest? The answer is, of course, that neither can do so except as a bookkeeping matter. Yet, in a deferred-payment investment the cash costs of carrying charges become part of the invest-

[1] In transactions concerning stock in a corporation it is called a *dividend rate*.

ment (Chapt. V, Sec. 2), and the investor is losing the interest which he might make if he invested them in current-return investments (Sec. 1). The cash expenditures he can and does record as such, but he cannot very well record this lost interest as an expenditure because he has not actually paid it out. Yet, if he does not take account of it, he will never know how his affairs stand. How can he do so? The clew is at hand if we remember that the value of a deferred-payment investment is increasing because of the positive cash and of what might be called negative interest expenditures on it (Sec. 1). Every complete set of accounts consists not only of records of expenditures and receipts but also of changing values of assets (Chapt. VII). On this latter set of books the value of deferred-payment investments is "written up" annually by an amount equal to cash costs plus interest. The value thus obtained is called *cost value* (Chapt. VIII, Sec. 1*B*).

Since it is very difficult and quite costly to keep a full set of accounts on all the cost items which go into carrying charges on deferred-payment investments in immature timber which is being held as part of forest or other property, more or less approximation goes into the write-up figures. Small owners who do not do much bookkeeping frequently neglect it entirely, and consequently they never know how much they make on forestry investments. Large-scale investors, however, cannot afford to be so casual. Accounting for compound interest in forestry investments is, therefore, a sound and practically desirable procedure even though the interest does not show up as a direct cost item. We shall see, however, in Chapter XV, Section 4, and in Chapter XIX, Section 4*B*, that there are conditions where the procedure does not apply but that they do not violate the general principle.

10. THE RATE OF INTEREST

A rate of interest is obviously one expressed by a specific figure, as 5 percent. Different transactions require different rates, but at a given time and place the average of these rates is known as the *current* or *prevailing rate* or simply as the *rate of interest*. This rate is subject to both long- and short-term fluctuations, the latter being important in forestry.

In speaking of an interest rate, simple interest is ordinarily understood; but, in dealing with long-range calculations, compound interest is implied. Since the bulk of transactions are at simple interest, the rate of interest is a simple rate. Its fluctuations, however, involve similar ones of compound rates which are necessarily mark-ups of the former. Since, in general, the current rate used in discount transac-

tions is the same as that employed for transactions involving ordinary interest, the term "rate of interest" is applied also to discount. Occasionally, short-term discounting transactions use a different rate which is referred to as the *discount rate.*

Many financial transactions involve ownership transfers of bonds or other property in which an interest rate is stated. This is known as the *nominal rate.* The *actual, real,* or *virtual rate* depends on what the purchaser pays for it. A $1000, 5 percent bond yields $50 a year but, if bought at $990, the rate earned on it is somewhat more than 5 percent; if acquired at $1100, considerably less. Since it costs money to maintain investments, the real rate of interest is generally less than the nominal. The term "rate of interest" assumes real rates. The transactions of stock exchanges, by expressing the best opinions (be they good or bad) of investors as to value of investments, automatically reduces nominal to real rates.

In banking it is customary to speak of *borrowing* and *lending rates.* The rate at which the bank pays its depositors is the borrowing rate, that at which it lends being the lending rate. By varying these two rates, the bank attempts to regulate the flow of liquid capital into investments of a more permanent nature—and secure a profit for itself. It is evident that a rate somewhere between the borrowing and lending rates expresses the current rate better than either rate.

Interest is often called the "price of money." Whether it is a price in the true sense need not concern us, but the rate of interest like prices is affected by law of supply and demand (Chapt. VIII, Sec. 3*D*). During periods of prosperity, when businesses are expanding, the demand for capital is high and rates go up; in depression times, when few businesses dare risk investments in plant expansion or in raw material stocks, they drop. Rates are likely to be higher in new and industrially undeveloped countries where capital is lacking and risks are great than in long-settled and well-developed regions. They are also higher in periods of currency inflation.[1] Rates for different types of loans and for individual loans are affected, in addition, by the individual risk involved. The greater the apparent risk to the lender, the higher the rate. Newly organized companies in untried fields usually must pay high rates. In times of extreme social stress, much capital is allowed to remain idle because owners are afraid to risk lending it, regardless of possible gains.[2] Strong governments, whose bonds are

[1] J. T. Shotwell, *What Germany Forgot,* Chapt. IV, The Macmillan Company, New York, 1940.

[2] J. M. Keynes, *The General Theory of Employment, Interest, and Wages,* Chapt. 15, Harcourt, Brace and Company, New York, 1935.

considered almost as riskless an investment as possible, nearly always pay lower rates than commercial and private loans.

In small communities, where the amount of local capital is small and the local banks or private lenders often have a monopoly, rates are higher than the general rate. Competition between lenders in the large capital markets tends, in times when capital is abundant, to keep rates down.

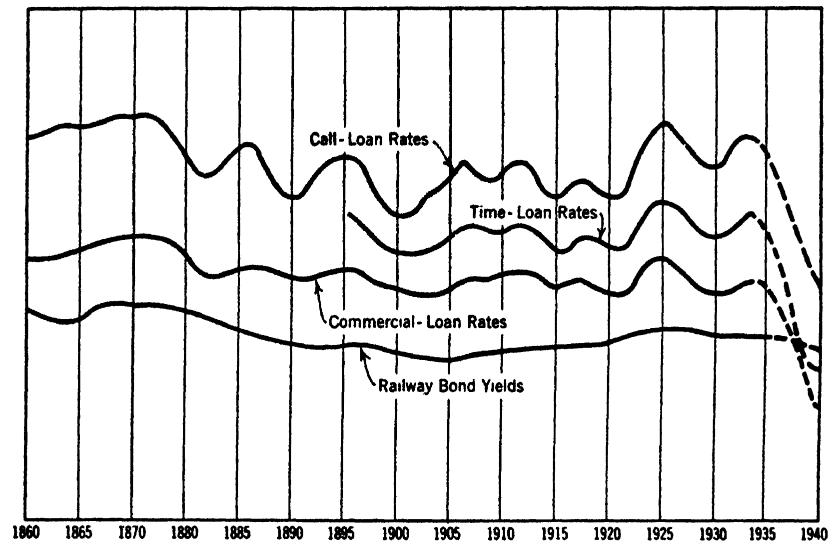

FIG. 6. Trend of interest rates in the United States (1860–1935) plotted on a logarithmic scale that is identical for the whole series. [After F. R. Macauley, *The Movement of Interest Rates, Bond Yields and Stock Prices in the United States Since 1856*, p. 230, Publication 33, National Bureau of Economic Research, New York, 1938. Used with permission of Bureau of Economic Research.]

An attempt sometimes is made to determine a so-called "pure" rate of interest, based on loans without risk and without any mark-up from relending. If this can be done it would give a sort of basic rate as a datum plane from which to measure current or special rates in accordance with their risk and with other special factors. Since there can be no such thing as an entirely riskless investment (Chapt. V, Secs. 4 and 5), it is difficult to see how such an interest rate can ever be determined. Apparently, the best thing is to take as a basic rate a figure which seems to be an average of conservative loans from large capital markets over long periods of time.

The general course of interest rates both in the United States and Europe has been downward for over a century, despite many fluctua-

tions in the trend and much differentiation between rates on different types of loans. The long-term trends for various kinds of loans in the United States are shown in Fig. 6. This chart is not constructed to show actual rates, and cyclic and seasonal fluctuations have been eliminated. The rates, however, vary widely. They range from a maximum of 24 percent for commercial loans in October, 1857, to 0.25 percent for call and time loans for several months in 1936.

Figure 7, Curve 1, shows the course of effective savings bank rates for two banks, one of them in operation for more than one hundred years, the other for nearly eighty years. For many years their rates have moved in practical unison. They appear to be representative of savings bank rates in general. Curve 2 shows in an index form the average yield of American railway bonds. Savings banks and railroad bonds have long been considered standard forms of conservative investments for investors interested primarily in safety. The aggregate amount of capital invested in them has always been large. Both series show a generally declining trend for over half a century.

There is a limited public control over interest rates in the United States, first, by so-called state usury laws which are designed to prevent the charging of exorbitant rates by "loan sharks." The so-called *legal* rates are usually higher than current bank rates for large loans. Action by the federal government affects certain classes of interest rates. It empowers the Federal Reserve Banking System to fix certain types of short-term rates using this power at times to prevent credit inflation. The federal government also makes loans at low rates for housing and other welfare purposes to individuals, corporations, or communities. The objectives are: (1) to provide funds in fields where it is difficult for the average borrower to obtain them at favorable rates; (2) to force down rates by private agencies on this kind of loans. Congress could authorize, but never has authorized, such loans for the benefit of those wishing to practice forestry. Frequently it is claimed that large-scale public lending has been one of the causes of declining interest rates. Whether this, if true, is to be considered a good or a bad thing depends on one's social and economic philosophy.

It would seem, solely on the basis of the data presented on the long decline in interest rates, that conditions are now more favorable for a flow of capital into forestry than at previous times. But two questions immediately come to mind: What about the future demand for forest products? What about the future course of interest rates? The first question is discussed in Chapter XII. As to the second, it is possible that the downward trend of interest rates may reverse itself; but

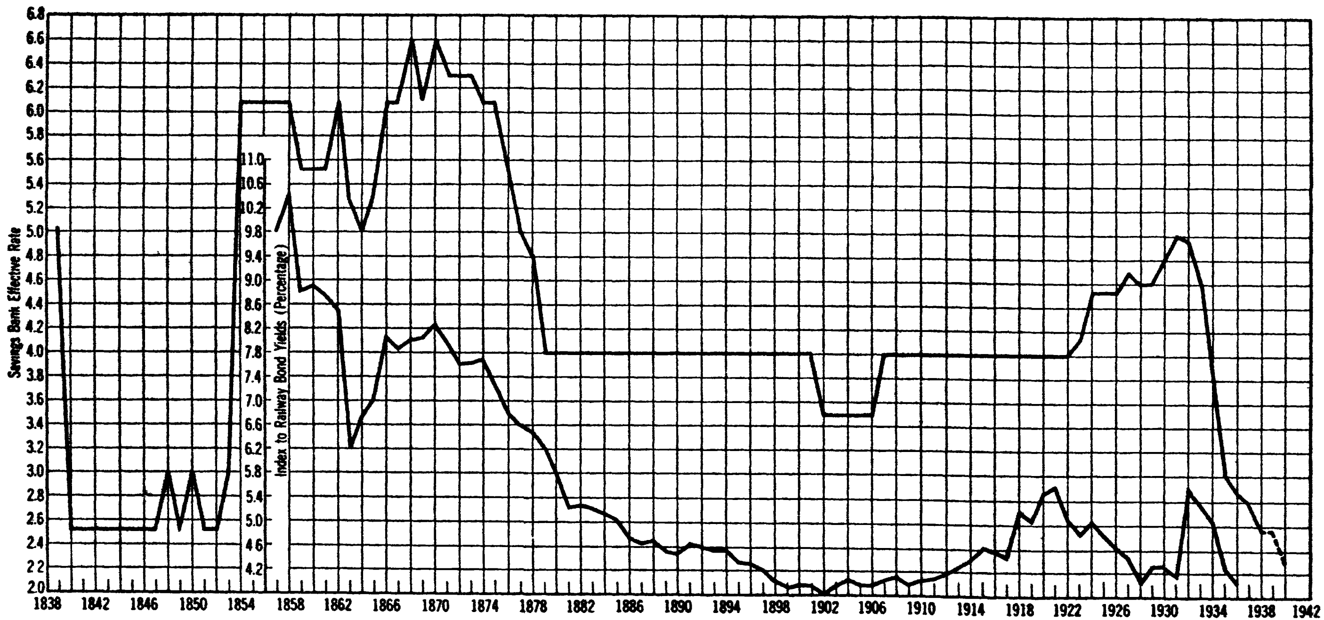

FIG. 7. Effective savings-bank interest rates (1839–1940) and index to railway-bond yields (1857–1935). Savings-bank data from two mutual savings banks in Connecticut, established in 1839 and 1858, respectively. Rates 1858–1940; average of rates prevailing in both banks. Interest was compounded semi-annually, 1839–1927; thereafter, quarterly. All rates have been reduced to an annual basis. When rates differed according to size of sum on deposit, maximum rate was used. Index for railway bonds is based on average yield of 4.776% as of January, 1925. [Data from p. 108, Macauley, *op. cit.*, Fig. 6.]

it is arguable that with the United States approaching its maximum population and with its productive plant well developed, the country, despite fluctuations in the prosperity curve, never again will see interest rates at high levels which prevailed in the past.[1] Even if this is true, it does not automatically follow that money will flow into forestry. Some of the factors involved are discussed in the next section.

11. INTEREST RATES IN FORESTRY

Forestry literature is full of discussions as to what interest rate should apply to forest investments. Two questions are involved: At what rate can money be borrowed for long term investments in growing timber? What rate can be earned by a given sum invested for the same purpose? In either case it is obvious that we are here concerned with a compound rate and that it has nothing directly to do with interest rates in ordinary business transactions of forest enterprises which involve simple interest only. It is also obvious that the two questions are interrelated. If the investment does not yield a higher rate than the rate of borrowing, the investor has lost money. If he uses his own money, even though the investment yields a profit, unless that profit is greater than he might have made by lending his money to others, he is, by financial theory, a loser.

The rate at which money can be borrowed from private sources depends upon (1) the general course of interest rates, as discussed in Section 10, and (2) the opinion of lenders as to the soundness of forestry investments in general and particular. They will wish, therefore, to examine the evidence on rates which may be earned. This involves an estimate of the cost of production of a crop of timber and a comparison with its estimated net value at maturity. In making the cost estimate, it is necessary to assume a rate of interest in order to figure carrying charges (Sec. 7*B*). The rate chosen will affect the cost. Yet, if the estimate is to be worth anything, this rate must have some relation to that at which money can be borrowed. It is difficult to break out of this vicious circle except by assuming various interest rates and seeing what happens, as in Chapter XIV, Section 13, where Fig. 46 illustrates that a forest investment *under a given set of costs, growth rates,* and *prices for products* will yield a profit at 3.5 percent compound but not at a higher rate.

Practical experience over a century has shown that the increase in value of a stand of timber over the compounded cost of its production

[1] J. H. Stoddard, Jr., "Recent Economic Trends on the Financial Aspects of Forest Investments," *Journal of Forestry,* Vol. 35, No. 6, p. 584, June, 1937.

is seldom sufficient to yield a high rate of profit. If the period of waiting is prolonged, the rate of increase in value declines, but the increase in costs is always at an accelerating rate. Consequently, unless the general level of forest products prices is greatly raised in the future (Chapt. XII, Sec. 7), forest investments seem destined to continue to yield only moderate interest rates. These rates, however, are compound, which mean more than the investor who is accustomed to think in terms of simple-interest rates (Sec. 1) realizes.

The situation being what it is, it has been very difficult to persuade owners to use their own money or capitalists to lend money for the longest-range enterprises in forestry, such as large-scale forest plantations of slow-growing species on bare ground, or even for holding very young stands for long periods before they ripen. At ordinary interest rates it is difficult to show even a theoretical profit for forest investments running over long periods, even by assuming very low cash costs and very high final values. The shorter the investment period can be made, either by growing quick-maturing species or by investing in natural growth as it approaches maturity, the shorter this waiting period and the more attractive the opportunities. Under these conditions interest rates earned may well exceed those possible from savings banks, a matter of considerable importance to small forest owners.[1]

The unattractive nature of these very long investments in forestry, coupled with the desirability from a public point of view of restoring to productivity large areas of denuded forest lands has given rise to much talk of public assistance to owners of such lands through the medium of long-term loans of low interest rate. Some tentative experiments have been made in this field, but large-scale developments are still to be developed in the future. An essential of such loans is not only that the rate be very low but also that the owner be relieved from annual interest payments which are known to increase more rapidly than the cash costs and eventually to exceed them. To meet the needs of owners, such loans therefore should not call for annual interest payments but should be deferred to maturity and paid along with the principal out of the proceeds of the crop. Loans in the form of discount bonds (Chapt. III, Sec. 4) might accomplish this. Deferment of tax payments until the crop matures is, in reality, another form of loan of somewhat similar principles (Chapt. XVII, Sec. 8). As discussed in Chapter XV, when forestry is rationalized by the use of sustained-yield methods, much of the difficulty regarding interest will disappear. The problem is to attain this objective.

[1] E. C. Herst, "A Savings Bank Investor Looks at Forestry," *Journal of Forestry*, Vol. 36, No. 8, p. 748, August, 1938.

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CHAPTER VII

APPRECIATION AND DEPRECIATION

The values of things are forever changing. The price of lumber goes up or down every day. The value of an automobile normally decreases with each mile it is run because, when it will no longer operate, it is only scrap metal. The value of a young timber stand may be expected to increase as it grows in volume and improves in quality. The articles of incorporation of a lumber company may say that it is capitalized at a million dollars, but its real value at a given time depends largely on its current earnings and its probable ability to maintain them. Even money changes in value.

When the value of an asset increases, it is said to *appreciate;* when it declines, it is said to *depreciate.* These changes affect all equipment, business, and investments and become increasingly important as the length of the investment increases. Hence, a business not only must keep track of expenditures and receipts from day to day but also must periodically revalue its capital assets, stocks of merchandise, raw materials, and other property so that their value will correspond to current conditions.

The purpose of this chapter is to discuss these changes in value and the methods of accounting for them.

1. CHANGES IN VALUE OF RAW MATERIALS AND FINISHED PRODUCTS

Raw materials are the basic physical asset of any industry and, in a sense, of society as a whole. Industries engaged in the harvesting or extraction of such materials must use a large share of their capital for the acquisition of such supplies, usually purchasing them far ahead of need. Large amounts of capital are tied up in reserves of mineral, oil, and timberlands, which may not be exploited for years to come. The current value of these investments varies with the prices of the finished products manufactured from them (Chapt. VIII, Sec. 3, and Chapt. X, Sec. 4). The relation is not usually a direct one but varies with the kind and uniformity of quality in the material involved. Assume a mineral deposit of absolutely the same quality and difficulty

of mining throughout. Its value then will vary entirely with the price. The higher it goes, the more the property is worth. But nature did not lay down mineral deposits in such a uniform fashion. The ore and difficulty of mining it vary throughout the deposit. Ore in different parts of the mine is, therefore, worth different amounts, depending on the combined factors of quality and accessibility. At a low price it will pay to mine only the best and most accessible ore; as the price increases it becomes profitable to mine lower- and lower-grade and

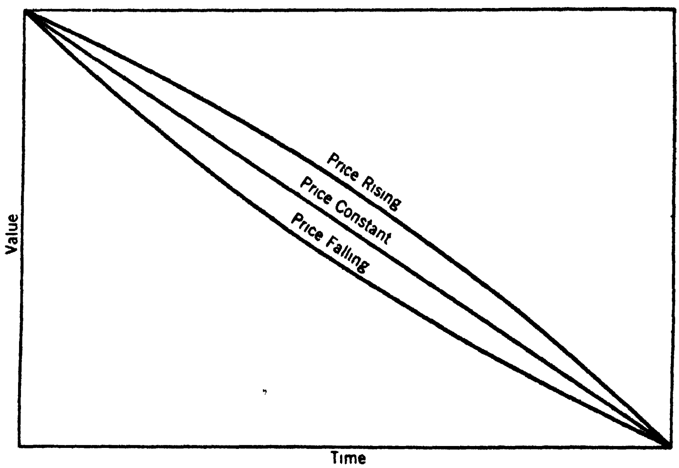

FIG. 8. Diagram illustrating decline in value of a mature stand of timber in a timber-mining operation under a constant rate of cutting but with different stumpage-price conditions. (See also p. 103.)

less and less accessible ore. Therefore, economically speaking, the amount of ore in a mine changes with the price even though geological forces do not work fast enough to affect the physical amount.

Economically speaking, the amount of timber in a forest also changes with the price, as is discussed fully in Chapter X, Section 3, but biological forces work fast enough also to affect the quantity of timber within a period short enough for human beings to take into account. From this point of view, forests may be divided into three classes: (1) mature, even-aged forests where decay exceeds growth and the amount of timber is declining; (2) immature forests which are increasing in volume; (3) all-aged forests where growth balances decay. Here, in the absence of human interference, the amount of timber remains practically stationary.

Let us examine changes in value in the light of price changes under these three conditions.

Case 1, Mature Timber. The slow decline in volume may or may not be offset by a price rise so that its value may be declining, may remain stationary, or may be increasing, depending on the relation of the factors involved. Assuming that such a stand is being clear-cut,

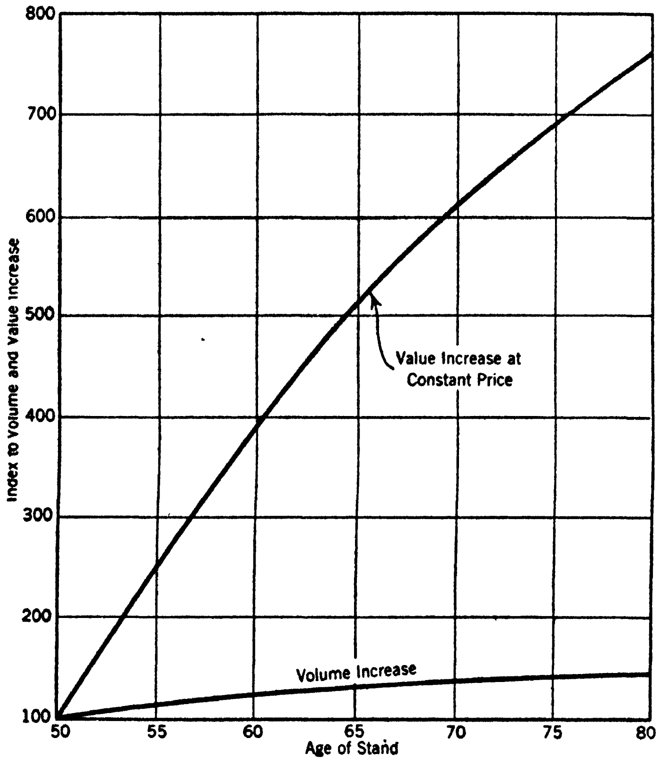

FIG. 9. Comparative indices of volume and value increases of a site index, 90 loblolly pine stand between its fiftieth and eightieth years, based on 1929 prices as applied to mill scale. Volume and value for fiftieth year equals 100. (See Chapt. VIII, Sec. 3*C*, for discussion of price and production indices and Chapt. VII, Sec. 5, for description of site indices.) [Data from: Tables 50 and 51, Volume, Yield, and Stand Tables for Second-Growth Southern Pines, Miscellaneous Publication 50, United States Department of Agriculture, 1920; Tables 5 and 17, Publication 43, Virginia Forest Service; Table XI, D. M. Mathews, *Management of American Forests,* 1935, McGraw-Hill Book Company, New York.]

if stumpage prices remain stable, the value of standing timber decreases with each log cut. If prices rise, the decline is slowed down. With a large rise, it even may be temporarily arrested but, if the cutting is not compensated by growth, the value of the investment falls to zero when the last tree is cut (Fig. 8). If the factor of decline in

volume from decay is added, this value is constantly lowered by this decay regardless of the other factors.

Case 2, Immature Timber. If prices remain unchanged, the value of such a stand tends to increase faster than the rate of growth (Fig. 9). If prices increase, the money value increases even faster. If prices drop, the increase in growth may or may not offset it, depending upon the relative rates of increase in growth and of decrease in price. It is possible but hardly probable that the drop in price may be sufficiently great and long continued so that at maturity the timber will be worth less than it was at an earlier period.

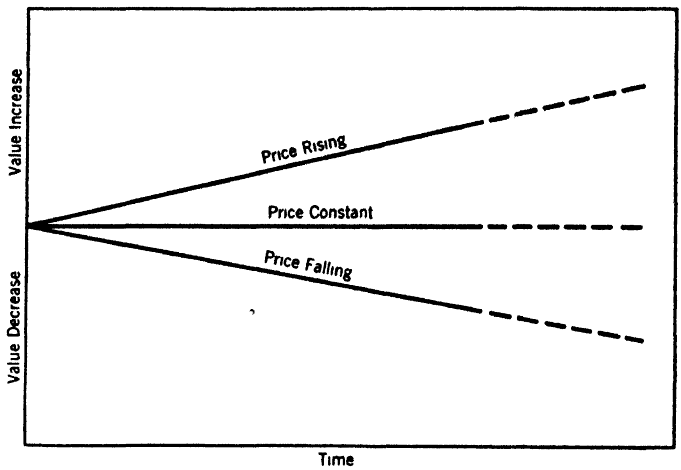

FIG. 10. Diagram showing changes in value due to variation in stumpage prices in a forest where growth balances cutting or decay.

Case 3, Forests Where Growth Balances Decay or Cutting. These forests may occur in nature and are called all-aged virgin forests or, under management, sustained-yield forests when the annual or period cuts equal the growth (Chapt. XV). In either case, the physical capital in growing stock remains constant, its value changing only with price changes. Figure 10 diagrams these relationships. This figure represents both all-aged forests in which growth balances decay and normal forests under sustained-yield management (Chapt. XV, Sec. 1).

Since prices are always undergoing minor changes independent of their long-range trends, none of the lines on these charts would be smooth in actual practice; they would be continually crossing the trend lines in an erratic manner.

Raw materials and finished products also change in value, owing to physical and economic conditions. Saw logs and stored lumber deteri-

orate in quality unless expensive means of preservation are resorted to, in which event they cost the owner more each day they remain unmanufactured or unsold; moreover, the price may go up or down. It must go up faster than storage costs or their owner will lose money. In certain classes of merchandise the obsolescence factor is extremely high. Women's hats, for instance, are practically valueless if not sold within a few months. This fashion obsolescence sometimes also reduces the value of furniture woods in the course of a few years, for instance, a change in fashion from maple to oak in dining-room furniture.

2. CHANGES IN VALUE OF EQUIPMENT

In addition to capital invested in raw materials, an industry must have a heavy investment in the equipment, including buildings and other structures, necessary to convert them into finished products. This equipment is also constantly changing in value. Unlike trees, crops, and livestock, it cannot grow in amount and quality but is constantly wearing out, and its value is therefore generally declining although this decline may be halted temporarily by price increases.

It has been said that every piece of physical equipment, be it an axe, a tractor, or a sawmill, is on its march to the junk heap, although by chance some pieces may land in a museum. The reason is simple. Equipment not only wears out but also becomes obsolete with the invention of more efficient types. A steam locomotive built seventy-five years ago, if it has been properly maintained, will still run, but its power is so low in relation to its fuel consumption that its operation is no longer profitable. In other words, its physical exceeds its economic life. With the exhaustion of large virgin timber, power skidders will probably become obsolete. Tractors and trucks are hastening the obsolescence of logging railroads. Most equipment, however, is worn out before it becomes obsolete. Each day it is used, it is that much nearer the scrap heap and consequently is worth that much less and, as the accountants say, has *depreciated* that much.

Aside, perhaps, from great works of art, historic structures, and the like, all the physical works of man, roads, canals, and buildings, even the most enduring, are subject to depreciation and obsolescence. Methods of evaluating depreciation are discussed in Section 4.

3. CHANGES IN VALUE OF MONEY

Money, like everything else, changes in value with time and place. Perhaps a dollar is always a dollar, but it will not always buy the same amount of goods. In other words, its *purchasing power* changes,

for, after all, the value of money is determined by what it will buy.[1]

If the price of a cup of coffee is 5 cents, one can say that a nickel is worth a cup of coffee with just as much truth as he can say that a cup of coffee is worth a nickel. If all restaurants raise the price to a dime, it may be said that nickels have gone down in terms of cups of coffee just as well as that coffee has gone up in terms of nickels. Either way, the value of a nickel has been halved so far as restaurant coffee is concerned. If, however, at the same time the price of another food item, say, a piece of pie, is cut from a dime to a nickel and no other item on the menu changes, the customer who wishes both coffee and pie pays the same price for his meal and the value of his money in terms of restaurant meals remains the same.

Prices are forever changing—some rise, some fall, a few remain stationary. At times rises cancel falls and the value of money remains approximately stable. At other times the majority of prices are either rising or falling but not necessarily in equal amounts. When prices as a whole are rising, the value of money is declining, and vice versa.[2]

Given statistical information about prices and about quantities sold of the commodities which enter into everyday life, varying from basic raw materials to finished goods of all kinds, it is possible to measure these changes in the value of money in terms of what the money will buy. Figure 11 is made up from such data and shows the changing purchasing power of the United States dollar over a 40-year period. Taking 1926 as a standard, that is to say, assuming a dollar to have been worth a dollar in purchasing power in that year,[3] it will be observed that it has varied in purchasing power from $1.81 in 1901 to $0.65 in 1920. By tracing the matter still further, it is found that in 1896 a dollar would purchase about 3.3 as much as in 1920 and about 1.7 as much as in 1938.[4]

The reasons for these changes in value of money are very complex and not all economists agree regarding them. Suffice it to say, therefore, that in days when most currencies were based on the gold standard, that is to say, the dollar, franc, pound, and other moneys, each representing a given weight of gold, the value of money varied with the available supply of gold. As the amount of gold increased through

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[1] For a more complete yet not involved account of this subject, the reader is referred to Fairchild, Furniss, and Buck, *Elementary Economics*, Chapts. XXII and XXVIII, The Macmillan Company, New York, 4th edition, 1939.

[2] Fairchild, Furniss, and Buck, *op. cit.*, p. 6.

[3] See discussion of index prices (Chapt. VIII, Sec. 3*C*).

[4] Chapter VIII, Section 3*B*, gives the method for changing money from its nominal to its real or purchasing-power value.

the discovery of new supplies or improved mining methods, it went down in price. In consequence, governments could buy their gold cheaper. This made their money of lower value. On the other hand, when, owing to the exhaustion of supplies and to other factors, gold became less abundant, the reverse process occurred and money became worth more. Since these changes usually took place rather slowly, things became adjusted without serious economic dislocation.

FIG. 11. Changes in purchasing power of the United States dollar, 1900–1938 (1926 = 100). [From United States Bureau of Labor Statistics]

Today most currencies are on a managed basis even though gold is still used to sustain them. By a *managed currency* we may mean (1) that it has a sliding scale of value, set in terms of either gold or some commodity or group of commodities, (2) that it is valued in a definite relation to the currency of some other country or group of countries. The value of a managed currency can be changed very rapidly at the will of the government issuing it, or it may be set at different values for foreign and domestic trade. Even though the attempt may be made to keep it at a constant value, this may not succeed and violent fluctuations may occur.

In the present disorganized state of world monetary systems, a good deal of foreign trade is conducted by barter between governments. So much crude rubber, for example, is being exchanged for so much pulpwood. The relative amount of labor necessary to produce each commodity is supposed to serve as the ratio between a ton of the one

and a ton of the other. This may be the beginning of an international currency on a man-hour basis (Chapt. VIII, Sec. 2*D*).

Rapid and violent changes in the value of money are very disastrous not only to business men and capitalists but also to people in general. They cause widespread suffering by throwing the entire economic system into complete disorder by either raising prices to disastrous heights or lowering them to disastrous depths. If the value of money sinks to very low levels, it may practically wipe out invested capital even though the physical plant which it represents is not affected and, in terms of depreciated money, even may be worth more. Actually, in terms of earning power it is worth less, for on account of the profound disturbances of economic conditions public purchasing power is so reduced that it is difficult to sell goods or to make any sort of financial calculation which will hold good long enough to justify acting on it.

This is what happened in Germany shortly after the first World War. The value of money fell so low that it took a few millions of marks to buy a postage stamp. When stability of money was finally re-established, those who had managed to hold or obtain ownership of physical property, land, buildings, factories, etc., had the properties and were in a position to use them productively. Those whose capital consisted of bonds, mortgages, and other paper assets had a lot of engraved wastepaper. The reverse phenomenon occurred in the United States from 1929 to 1933, when the value of money increased enormously and those who had money were able to buy cheaply (Fig. 11; compare Chapt. IV, Sec. 5, and Chapt. VIII, Sec. 3*J*).

Profound as are the changes in values, owing to monetary changes such as those discussed above, they cannot well be taken account of in bookkeeping, but they do have a great effect on business and investments. They are discussed further in Part III.

4. DEPRECIATION AND DEPLETION CHARGES

It is necessary in a business to take account of changes in value, such as were discussed in Sections 1 and 2. This requires (1) an estimate of how fast the assets in question will probably decline in value, and at what period their value will have become zero; (2) the keeping of accounts to show their value at all times or at least at periodic intervals; (3) the setting aside of reserves from earnings to replace the worn-out or used-up assets which are essential to the conduct of the business. This section and those following it are devoted to these problems.

Although all equipment eventually becomes valueless from depreciation or obsolescence, it is frequently difficult to forecast the length of the physical or economic life of a particular article; nor does it necessarily depreciate at a constant rate. Like an automobile it may depreciate faster in early life than later (Fig. 12), or like steel rails more rapidly in its later life. In any case, it may be rendered obsolete by the invention of a better article long before it is worn out.

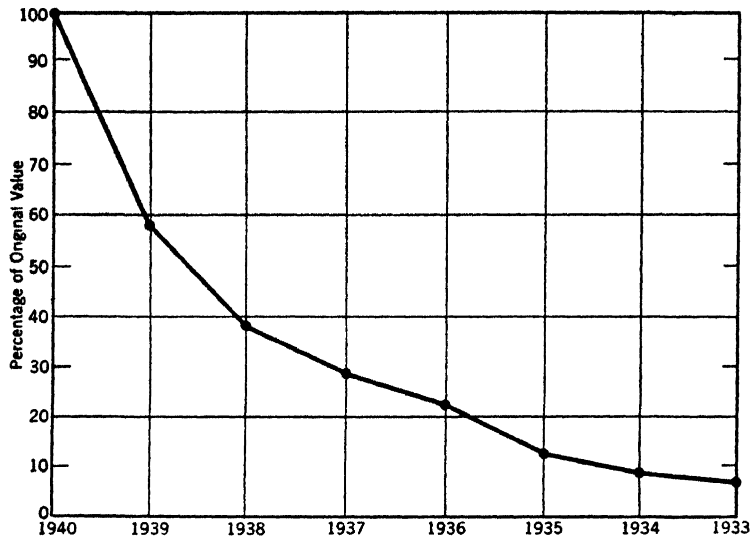

FIG. 12. Depreciation curve for a standard make of light-motor truck. Figures indicate percentage of value of original price in 1940 of models built in the years indicated. Thus in 1940, a 1937 model had an average resale value of 29.27% of its original factory price. [From *Official Used Car Guide,* a National Automobile Dealers Association, 1940, District B Edition.]

No one is sure the length of time heavy steel, masonry, or cement structures will last or whether they will ever become obsolete. Even *salvage value* (Chapt. VIII, Secs. 1*B* and 8) is more or less problematic. The salvage value of a truck, built in 1941, depends on the price of scrap steel in 1948 or 1949.

Therefore, accountants and engineers make the best guess they can as to the probable economic life of an article and then, in the face of numerous other methods,[1] depreciate it, usually adopting the *straight-line method.*[2] This consists simply in dividing the number of years

[1] L. R. Perkins and R. M. Perkins, *The Mathematics of Finance,* Chapt. V, John Wiley & Sons, New York, 1941.

[2] So-called because the values plotted on a graph would be a straight line, whereas the values of other methods so plotted would be curves.

of assumed life into the original cost and writing off the resultant sum each year. Thus a $1000 machine, assumed to last ten years, would decrease in value at the rate of $100 a year, in which event it would be said to depreciate at the rate of 10 percent per annum even though its actual decrease in value might follow more the pattern of Fig. 12.

The United States Forest Service depreciation tables for logging and milling equipment used in stumpage appraisals are introduced in Chapter XVIII.

The following tabulation quotes certain depreciation rates which have been allowed by the courts in income tax cases.[1]

	Percentage of Annual Depreciation
Brick and steel buildings	1– 2
Frame buildings	4–10
Frame residences	4– 5
Automobile trucks	10–33⅓
Furniture	5–10
Machinery in general	2–20

Natural resources, such as ore bodies and standing timber which are being mined, are also usually depreciated by the straight-line method, but the charge is usually called *depletion* rather than depreciation. If the total amount of timber or ore is known, the amount which is actually used up may be "depleted" each year at current valuation. This allows for keeping track of supply, but the actual remaining supply is seldom known because the amount of ore or timber removed each year depends to some extent on price levels (Sec. 1). Therefore, this procedure is not always entirely satisfactory as a write-off method.

In dealing with natural resources, certain works necessary to exploit them are useless after the exploitation is complete. A mine or logging railroad, built solely to remove ore or timber, is useless when the operation is complete. It must therefore be depreciated to zero (except for salvage values) in the same length of time that the ore or timber is expected to last. This applies to buildings or other equipment which cannot be moved or to the cost of moving which would exceed their value.

Since it is necessary to set up reserves to cover the cost of replacement due to depletion, depreciation, and obsolescence (Sec. 6), it is considered good business practice to use a high depreciation rate so that there is always provision for replacement ahead of possible need. If the article is still serviceable after it has been depreciated to zero,

[1] J. K. Lasser, *Your Income Tax*, p. 49, Simon and Schuster, New York, 1941.

it is said to be "paid for," and all that it earns above operating expenses is treated as profit.

A rapid write-off of assets, like a rapid payment of debts, therefore increases the financial strength of a company. It also affects taxation. If a company can convince taxing authorities that a building depreciates at a rate of 10 percent per annum, presumably it should not be taxed heavily after its 10th year. Consequently, tax laws frequently set up regulations as to depreciation rates and methods (Chapt. XVII, Sec. 10).

A rapid depletion rate may put a heavy strain on a business liquidating a natural resource because it cannot set aside sufficient reserves to meet it; so such rates usually must be adjusted somewhat to business conditions.

5. EXHAUSTION AND REPLACEMENT OF CAPITAL AND ASSETS

The original capital invested in a company is expended for raw materials and means of production. Immediately operations start; the depletion of raw materials and depreciation of equipment begins; so that, although the capitalization of the company remains yet unchanged, if the actual capital is not replaced as it is exhausted, the company sooner or later finds itself without sufficient capital to continue.

Let us follow this exhaustion and replacement of capital in a lumber operation by presenting two dummy accounts, one of which shows depreciation and depletion, the other the setting up of reserves for replacement. Assume that the Rugged River Lumber Company was capitalized at $1 million, of which $500,000 was in common stock and the rest was in the form of a bond issue, maturing in 10 years, at which time it is expected that the timber will be exhausted and the operation closed. All the capital was used immediately to purchase land and stumpage, conversion equipment, and improvements, such as mill, logging equipment, and roads. Operations were started January 1938.

At the end of each year its depreciation and depletion account will be shown in a form of the general nature of Table 2. Each year the values in Columns 5 and 6 will decrease. Those items which wear out in less than 10 years will have to be renewed before that time and will have to be replaced at least once and the depreciation cycle started over again. At the end of the tenth year all figures in Columns 4 and 5 will be zeros.

Although the figures in both Columns 4 and 5 represent present value, they will seldom or ever agree, those in 4 being based on cost

value less depreciation, those in 5, on estimated present sale value. Whereas figures in Column 5 are the better criteria of what the property might bring if sold, those of 4 are a better measure of depreciation for the purpose of setting up reserves (Table 3).

TABLE 2

RUGGED RIVER LUMBER COMPANY

Depreciation and Depletion Account As of Dec. 31, 1940

(1) Items	(2) Original Cost	(3) Less Depletion or Depreciation	(4) Present Value [1]	(5) Inventory Value
Land and timber		[3]		[2]
Mill and equipment		[4]		[7]
Logging railway and rolling stock		[4]		[7]
Logging equipment		[5]		[7]
Other non-expendable property		[6]		[7]
Total				

1 Column 2 minus Column 3.
2 Based on stumpage prices prevailing in December, 1940.
3 Based on 2 years' cut plus allowance for growth of uncut timber.
4 Based on 10-year life less estimated salvaged value; straight-line method used, as also in (5) and (6).
5 Based on 5-year life less estimated salvage value.
6 Based on 3-year life no salvage value.
7 Based on estimated value for immediate sale.

If the Rugged River Company wishes to remain in business even for 10 years, it must do something about (1) its bonded indebtedness, (2) the replacement of such of its equipment as will not last for 10 years. Obviously it not only must keep up its interest on its bonds but also must have enough in its treasury to pay them off not later than the tenth year and must save enough to replace worn-out equipment as necessary. If it wishes to continue in business after it has exhausted its 10-year supply of timber, it must save funds to purchase more. The only way it can get money [other than by continually borrowing, which is usually impossible and always dangerous (Sec. 6)] is to set money aside from earnings. Accordingly it sets up a number of reserves or funds which are allowed to accumulate to take care of the obligations when due. These reserves or funds have special names

according to their purpose and how they are set up. The two common kinds are sinking funds and amortization accounts (Sec. 6). Table 3 shows a dummy form for the various reserves and funds necessary to take care of the bonded indebtedness and for replacements of the capital used up by depletion and depreciation in Table 2.

TABLE 3

RUGGED RIVER LUMBER COMPANY

Amortization and Sinking-Fund Accounts As of Dec. 31, 1940

Item	Required at Maturity	Amount [1] As of This Date
Sinking fund for timber depletion and replacement, due January, 1948		
Sinking fund for mill and logging roads, depreciation, and replacement, due January, 1943		
Sinking fund for logging equipment depreciation and replacement, due January, 1943		
Sinking fund for miscellaneous equipment, depreciation, and replacement, due January, 1941		
Amortization of bonded indebtedness, due January, 1948		
Total		

[1] In view of the interest factor involved in sinking-fund and amortization accounts, a full statement of each account would involve more entries than are shown here (Sec. 6).

It is evident from the schedule in Table 3 that the company desires to set up a timber depletion and depreciation fund sufficiently large so that it can start its next operation free from debt.

Public as well as private property depreciates, and provision should be made for its replacement. However, although public bodies usually set up sinking or amortization funds to retire bonded indebtedness, they seldom go so far as they should to make advance provision for replacement of depreciation in public buildings and other depreciable property.

On the other hand, they seldom take adequate precaution to protect themselves from the depletion of natural resources in private ownership. It must be remembered that the depletion of mines, oil wells, forests, and the like may be a perfectly legitimate and profitable private business but, even though the owners profit, the public frequently loses if from no other cause than from loss of tax receipts. Taxing

authorities, however, at times do push up tax rates on property which is being depleted at a rapid rate in order, as one might say, to secure advance compensation from future losses (Chapt. XVII, Sec. 5*B*, Case 2).

6. SINKING FUNDS AND AMORTIZATION

A sinking fund is a special fund into which a fixed amount is paid annually (or at any other fixed interval) and allowed to accumulate at compound interest till it reaches the required amount. Such funds may be established to accumulate money to replace losses by depreciation, to purchase new assets, or to pay off debts when due. It is obvious from its definition that a sinking fund is an annuity (Chapt. VI, Sec. 6). The problem is not to determine the amount of the annuity but rather to determine the sum (AR) to be paid each year (or other period) to yield the necessary sum in the time available. Formula 6—the annuity formula—

$$V_n = \frac{AR(1.0p^n - 1)}{0.0p}$$

can be arranged to make AR the unknown quantity, thus becoming

$$AR = \frac{V_n}{\dfrac{1.0p^n - 1}{0.0p}} = \frac{V_n(0.0p)}{1.0p^n - 1}$$ [*Formula 11—Annual Payment on a Sinking Fund*]

Problem. A logging company has purchased at $4000 a tractor which it expects will last 5 years and will have a salvage value of $100 at the end of that time. It wishes to set up a sinking fund to buy a new tractor at the end of the fifth year. Assume that it can invest its sinking-fund payments at 5 percent in the securities of a company manufacturing sawmill machinery. How much will it have to put into its sinking fund annually to have the necessary $3900 in 5 years?

There are three common methods of solution of Formula 11.

(*a*) Use of $1.0p^n$ tables (Column 1, interest tables, Appendix).
(*b*) Use of annuity tables (Column 3).
(*c*) Use of sinking-fund tables.

Method 1. Use of $1.0p^n$ tables. Substitute as follows in Formula 11 in its modified form.

Solution.
$$AR = \frac{V_n(0.0p)}{1.0p^n - 1} = \frac{3900(0.05)}{(1.05)^5 - 1} = \frac{195}{1.27628 - 1}$$
$$= \frac{195}{0.27628} = \$705.80$$

Method 2. Use of annuity table. This method derives from Formula 11 in its first form:

$$AR = \frac{V_n}{\dfrac{1.0p^n - 1}{0.0p}}$$

Determine value of the lower half of the right-hand side of the equation from annuity table (Column 3, interest tables, Appendix) and divide into V_n.

Solution. $$AR = \frac{3900}{\dfrac{(1.05^5 - 1)}{0.05}} = \frac{3900}{5.5256} = \$705.80$$

Remarks. Check with Methods 1 and 3.

Method 3. Use of sinking-fund table. Ascertaining from a sinking-fund table that the sum necessary to obtain \$1.00 in 5 years at 5 percent is 0.180975, we have only to multiply by \$3900 = \$705.80

Remarks. Checks with Methods 1 and 2.[1]

There are numerous and much more complicated sinking funds than that presented above. They involve interest-bearing obligations and funds which do not pay the same interest rate as the obligation, but the general principles are the same. The interested student is referred to standard works on mathematical finance.

As a matter of practice, a company would seldom set up a sinking fund for a single piece of equipment, being more likely to set up a general sinking fund to cover its entire depreciation and depletion schedule. A sinking fund, established to pay off a bond issue when due, would probably be set up as a separate account. The money which goes into such funds may be in securities, may be held in savings banks, or may be invested in any way that the company deems advantageous.

Other methods besides the sinking fund are also used to pay off interest-bearing debts. The most common is the so-called *amortization method.*[2] It consists in paying off a debt principal plus interest in equal, usually annual, installments. A little reflection is sufficient to make clear that, if the money for the tractor had been borrowed and an annuity set up to pay for it—principal plus interest on the borrowed money—Formula 11 would apply equally well.

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[1] See D. H. MacKenzie, *The Mathematics of Finance,* McGraw-Hill Book Company, New York, 1937, or other works on financial mathematics for sinking-fund tables.

[2] From the Latin *mort,* meaning here "to kill off." The best way to kill a debt is to pay it.

7. REVALUATION OF CAPITAL

In the light of the changes in value which we have been discussing, it is evident that the initial capitalization of a company, based on the par value of its original stock (Chapt. III, Sec. 3), sooner or later ceases to have much relation to its actual capital. Since the only use made of the capitalization figure is as a basis for figuring cash dividends in terms of a percentage, this is not necessarily important; but, if the capitalization is out of line with the actual capital, the dividend rate is not very revealing about the actual condition of the business. If the capitalization is low the dividend rate will appear high, whereas if it is high the same cash profit will show a smaller rate (Chapt. VI, Sec. 7).

As the actual capital changes, it is therefore sooner or later desirable to change the capitalization either by borrowing new capital to meet the needs of growth (if it cannot be supplied fast enough from earnings) or by reducing it to realistic proportions to take account of inflated values.

While the formal capitalization of a company does not include borrowed capital in the form of bonds or other long-term obligations, the money obtained from them is actually expended to acquire business assets of a fixed nature. To take account of this, the term *capital structure* is used to cover both. Thus the capital structure of the A.B.C. Plywood Corporation might consist of $500,000 in common stock, $100,000 in preferred stock, and $400,000 in 6 percent first-mortgage bonds with a 20-year maturity. Any consideration of the affairs of a company must consider its capital structure as well as its capitalization, and it is of much more practical importance that its capital structure rather than its capitalization be in line with realities of the situation.

When an enterprise fails to "write off" (to use the accountant's term) its depreciated capital assets, it is said to be *overcapitalized.* If it fails in accounting to note increases in value of its assets or to provide new capital to meet needs for new growth, it is said to be *undercapitalized.* The classic example of overcapitalization in America is in its railways, which are struggling to make earnings on capital investments in trackage and equipment, long obsolete but never paid for. This may not be the only factor in the railway situation, but it is certainly one of the more important.

Many enterprises have been unable to increase their capital sufficiently to permit their growth and are to that extent undercapitalized. Forestry as a whole in the United States, in a broad sense, may be

said to be undercapitalized in that it has not been able to obtain sufficient capital, public or private, to expand its activities to the point of realizing its full potentialities.

Individual forest enterprises, of course, may be undercapitalized or overcapitalized. A company may be in an excellent position, owing to the quality of its timber tract, the nature of market, and the like, to go on a sustained-yield basis (Chapt. XV, Sec. 6) but be unable to raise the necessary extra capital to do so and therefore obliged to continue on a liquidation program. On the other hand, it may be staggering under such a heavy debt load in paying interest on past borrowing, spent for improvements or timber long since exhausted, that its only recourse is bankruptcy.

The bankruptcy route is a common method of getting rid of overcapitalization due to failure to write off depreciation and depletion. The concern fails; its creditors or others take over its assets, revalue them at current rates, and start operations at a capitalization which corresponds to realities, and without a heavy debt load. The process is going on all the time—to the distress of stockholders and the joy of new owners who, in a sense, may get something for nothing.

CHAPTER VIII

VALUE, COST, PRICE, AND PROFIT

Value is the quality that makes an object or a piece of property useful or desirable. The *profits* of a business depend upon the relative values of what it buys, in order to carry on the business, in comparison with what it sells.

The *prices* the producer pays for the materials and services necessary to produce goods are usually referred to as *costs of production* or simply as *costs*. Thus, the difference between *costs* and *prices* is the difference between the point of view of buyer and seller. The money paid by a lumberman for a truck represents one of his *costs of production,* but for the automobile manufacturer it represents the *selling price* of one of his products. One expects a profit from the *use* of the truck; the other, from its *sale.*

Relative values, expressed in money terms, determine both prices and costs. We pay 50 cents for a movie ticket because we expect 50 cents' worth of entertainment *value* from the expenditure. The moving picture operator sells it at that price because it exceeds his costs.

1. VALUES

A thing may have value not only to its owner or to prospective purchasers but also to a large group of persons, perhaps a whole nation, who are in no way connected with its ownership but who profit by its existence or use. A telephone system has value not only to its owners but also to those who work for it, its subscribers, and directly or indirectly to all inhabitants of the community. To its owners, it has *individual* or *private* value; to the others, a *community* or *public* value or, in the largest sense of the word, a *social* value. Since many of the values of forests are public or social, these require consideration in forestry, but many of them, however real, are difficult to measure and are called *intangible.* A *tangible* or *material* value is one that is generally recognized by all, and is easily reducible to terms of money, for example, a loaf of bread. An intangible value is one not generally recognized or, if recognized, difficult to reduce satisfactorily to money terms.

Finance and economics recognize only values capable of reduction to terms of money. This includes all tangible values and such intangible ones as can be evaluated in money. A world-famous work of art is commonly referred to as "priceless." Its beauty is of a nature that everybody can appreciate; if destroyed, it could never be replaced. The expression "priceless," therefore, is justified. If the owner should decide to sell, art experts would have no real guide on how to set its price, and that set price would only represent their best guess as to what some museum or collector would pay. If finally sold to the highest bidder, neither buyer nor seller would know whether "the price was right," even though it would be said to represent its value. Once a price, no matter how determined, has been set upon an intangible value, it comes within the sphere of economics and finance.

In forestry we deal with the following kinds of values.[1]

A. INTANGIBLE VALUES

1. Sentimental values.
   (*a*) Those personal to an individual or small group.
   (*b*) Those shared by a large group, such as a community or even a nation.
2. Artistic or aesthetic values.
3. Scenic or landscape values.
4. Recreation or recreational values.
5. Scientific values.
6. Indirect values of a material nature which are difficult to define, such as watershed protection.

B. TANGIBLE VALUES

1. Use or utility value.
2. Scarcity value.
3. Monopoly value.
4. Luxury value.
5. Nuisance value.
6. Speculative value.
7. Liquidation value.
8. Residual value.
9. Appraised value.
10. Assessed value.
11. Cost value.
12. Capital value.
13. Realization value.
14. Replacement value.
15. Market or sale value.

A. Intangible Values. Under the following headings, the intangible values mentioned above are defined and their relation to forestry is discussed.

1. SENTIMENTAL VALUES. Objects or places have sentimental values because of past associations of an emotional nature. They are real

[1] In individual cases there may be overlapping of two or more of these values.

only to the individuals concerned and may be entirely unconnected with either material or aesthetic values (*A*2). Individuals or families might value highly an heirloom that was ugly, useless, and of the cheapest materials. When all the citizens of a community or a nation place a high sentimental value on a building where a historic event happened or on a field where a battle took place, that sentimental value may transcend all others, tangible or intangible, and justify the purchase of the building and field because of their *historic* value. The sentimental value of a tree under whose shade a great event took place may justify much expense to protect it and to prolong its life even though it constitutes a traffic hazard and is so old and decrepit that it has lost all beauty.

2. Artistic or Aesthetic Values. These values arise from human appreciation of beautiful or emotionally satisfying objects whose form, color, or texture give emotional satisfaction. When natural objects and scenery have these values they are called scenic or landscape values.

3. Scenic or Landscape Values. These values are important in certain aspects of forestry. The public preservation of bodies of virgin or beautiful old-growth timber for its scenic value may justify greater expense for its acquisition and protection than if only present or prospective timber value was considered (Chapt. XVI, Sec. 2).

4. Recreation Value. This value pertains to places and things that give the users a sense of physical and emotional satisfaction from the combination of scenic beauty with the opportunity for physical exercise. A forested mountain has recreational value because the climber is rewarded for his physical exercise in climbing it by the scenes on the way up and by the distant views from the summit. However, scenic value is not recreational value unless many people use and enjoy it. There are hundreds of mountain peaks and millions of acres of beautiful forests that have no present recreational value because they are so remote that few people use them. In the future some of them may be used for recreational purposes. Where this can be foreseen, they may be said to have *prospective* or *potential recreational* value (Chapt. XVI, Sec. 2).

5. Scientific Value. Certain articles, places, plants, animals, and archeological remains, because of their uniqueness or rarity, may have great value to science as objects of study. Often they cannot be replaced if destroyed. In such cases they have *unique scientific* value. The few remaining virgin forests in the eastern United States are of extreme importance to foresters, botanists, and ecologists as objects of

study, and promote a deeper knowledge not only of forestry but also of life processes in general.

It is obvious that two or more of the above values may adhere to the same place or object. A virgin forest, properly situated, may have scenic, recreational, scientific, and even sentimental value. None of these values, whether individual or social in nature, are subject to precise or even approximate financial measurement. In some forests they can be compared with tangible values that may help in their evaluation. To a nearby community a tract of old-growth timber may have obvious recreational value that cannot be determined accurately in dollars (Chapt. XVI, Sec. 2); however, both the land and timber have a material value. Its total tangible value is, therefore, that of land plus timber. The question is: Does the community consider it worth more or less than this for a public park? If less, it is improbable that they can buy it because the owner will not sell for less than he can get for land and timber.

6. Indirect Material Values Difficult to Measure. The social value of a telephone system to the general public is universally admitted. It is shared by all and is material. It is classed as intangible only because it is so hard to measure. If the community wishes to buy it, its sale value would probably be based on physical valuation of the plant or on its earning power, which might have little relation to its value to the community.

In forestry we deal with several sets of indirect material values not connected with scenic or other intangible values already listed—values such as watershed protection, flood control, stream regulation, and erosion prevention. They are intangible only because they are difficult to evaluate, but they may be susceptible to some degree of negative physical measurement, by determining the loss of property or income resulting from their destruction, as of a forest that prevents soil erosion in neighboring fields. The evaluation of money loss depends upon many factors (Chapt. XVI, Sec. 1).

B. Tangible Values. In describing tangible values, two sets of descriptive terms are used: those referring to kind or quality of value and those defining the method used to determine it or the purpose for which it is determined. The first group does not require expression in monetary terms; the second group does.

1. Use or Utility Value. Use is the basis of most tangible values which are measured by the relative profitableness of different ways

of using an article or piece of land. Land in cities has a higher use value than land in the country because more people live and work on it; hence it is more expensive.

2. SCARCITY VALUE. Mankind is likely to attach importance to things that are rare, apart from their usefulness. When they are both rare and useful, like platinum, they have high scarcity value.

3. MONOPOLY VALUE. This is an artificial scarcity value, created by human control of a product or property (Sec. 3*H*).

4. LUXURY VALUE. This value pertains to expensive or rare articles irrespective of their utility, for human beings enjoy possessing such objects and will pay more for them than their use value. A mahogany table is no more useful than a pine table, but it costs more. Trade in rare woods, used in expensive furniture and parquetry, is based on luxury value. It may or may not be associated with artistic value. Private forests on expensive land, where no cutting or other use is allowed, sometimes are called *luxury forests* (Chapts. IX and XVI).

5. NUISANCE VALUE. A piece of property may be used in such a way as to cause inconvenience or loss to another person. He may be willing or obliged to buy it at more than it is worth in order to get rid of the inconvenience or loss. Such property is said to have nuisance value. A common example is a landowner, situated near a public park, who operates a refreshment stand catering to park visitors. He may run the stand so that, although the land is not needed for park purposes, the authorities may buy it at a high price in order to get rid of the nuisance it may be. Small private holdings, surrounded by land where forestry is being practiced, often have a nuisance value because they create fire and other special hazards.

6. SPECULATIVE VALUE. Property expected to increase in value by an unknown amount is said to have a speculative value equal to the amount the purchaser expects to receive when he sells.

7. LIQUIDATION VALUE. This value is obtained from a property by exhausting all or most of its productivity. Thus, the liquidation value of a mine is the value of all the ore taken from it or that of a forest which is clear-cut, with all the timber removed (Chapt. XV, Sec. 5).

8. SALVAGE, WRECKING, OR RESIDUAL VALUE. This is the value that remains in a property after its usefulness for its original purpose is gone. The salvage value of a worn-out truck is that of the scrap metal it contains; that of a mine, the little its abandoned machinery and working equipment will bring (Chapt. VII, Sec. 4).

9. APPRAISED VALUE. When an attempt has been made to calculate in money terms the exact amount of all types of values possessed by a

piece of property, the resulting sum is known as its appraised value, the determination process being called an *appraisal.* It must always be in terms of stated values because a property may have different uses and hence different values. (A piece of land on the outskirts of a city will have a higher value if appraised for building lots than if valued for a corn field.) Appraisals made by different persons usually will have different results, even if based on the same use and by the same method, because the personal element enters into all appraisals.

10. Assessed Value. Assessed value is set upon property by public officials for taxation purposes. The basis used is supposed to be sale value (*B*15 and Chapt. XVII, Secs. 4 and 5).

11. Cost Value. This is the present monetary value of a piece of property, as determined by the sum of all its past costs to the owner, to which compound interest at a given rate on the sums invested is added. A probable cost value may be set upon property at a given date in the future by adding expected expenses plus compound interest on them to cost value at present. Present cost value serves the owner as a basis for determining the rate of profit from ownership or the selling price if he wishes to sell. Estimated future cost value is one of the bases for calculation of future profit. It is used in calculating the earnings of forestry (Chapt. XIV, Sec. 13). However, it is a value peculiar to the owner, and it may or may not influence possible purchasers (*B*15, sale value).

12. Capital Value. Capital value is a mathematical determination of use value obtained by capitalizing present earnings on the assumption that they will be perpetual or will continue for a given time; or, if the earnings will only be realized in the future, by discounting them to the present (Chapt. VI, Secs. 7 and 8*I*). Since this value is determined by a discounting procedure, it is often called *discount* value. As it applies only to the present, it is also referred to as *present* value, and because it is based on an expectation of future earnings it also goes by the name of *expectation* value. Used for the purpose of determining the value of forest soils for growing trees, it is called *soil* value or *soil-expectation* value (Chapt. XIII, Sec. 6*B*).

13. Realization Value. Raw materials are less valuable than the finished products into which they are made (Sec. 2*B*). The difference between these two values is known as *realization* or *conversion* value (Chapt XVIII, Sec. 3).

14. Replacement Value. This is a general term for the cost of replacing an article or structure that has been destroyed. As used in forestry, it expresses the cost of restitution to an owner whose forest has been destroyed. In determining replacement value for physical

structures the present cost of construction is used, but this value is differentiated for the same length of time and in the same manner as if these costs had been incurred at the time of its original construction. In ordinary use the term implies the present cost of physical replacement of the property to the condition in which it was immediately before destruction. Since this is possible in forestry only for very young plantations and small shade trees, it may be defined, for purposes of use in forestry, as *the value of a forest, based on what it would cost plus interest at a given rate to produce an equivalent stand in kind and volume.* If the original prices prevail at the time of destruction, it is equivalent to cost value. Since this is *never possible,* prices prevailing at the time of destruction are used. It is therefore a modified form of cost value (*B*11). This value is one of the bases for appraising damages to forests (Chapt. XVIII, Secs. 8 and 9).

15. MARKET OR SALE VALUE. For ordinary commodities bought and sold every day, certain standard values or prices have been arrived at, known as market or sale values (Sec. 4). When property for which there is no such standard value is sold, its price must be mutually agreed upon by buyer and seller after each has appraised it on the basis of the values it contains for him. In many cases the buyer and the seller will include different values. The owner may give his property a sentimental value (*A*1), for which the buyer naturally will be unwilling to pay unless it is also a historic value (*A*2). A historic value he may recognize and be willing to pay for because of pride of ownership. Likewise a farm woodlot may contain old timber along a picturesque stream which, to a buyer looking for a cottage site, would give it special attractiveness that the farmer probably would not think of unless sales in the region were made on a basis of scenic value.

Even tangible values may differ greatly to buyer and seller because one thinks in terms of a higher and the other of a lower use value (*B*1), as farm land versus city lots; or one may think of present and the other of future use, as to one a stand of young pine may be so much brush spoiling a pasture, whereas to the other it may be a potential stand of pulpwood. Or the seller may think of what it cost him to buy, produce, hold, or improve a property (*B*11), whereas the buyer thinks of how much income he can get from it and how much he can afford to pay to get that income.

In all cases the seller usually sets a maximum price he hopes to get and a minimum below which he will not sell. The buyer sets a minimum for which he hopes to buy and a maximum beyond which he

will not go. Inside these limits a price must be agreed upon that is the resultant of the seller's desire to sell and the buyer's desire to buy the property.

Except at a forced sale when the buyer takes advantage of the seller's need to dispose of his property quickly, or the seller of the buyer's need to acquire it, the price paid is assumed to represent the value of the property. Market or sale value is therefore usually taken to be the final criterion of value of property at a given time and place. As seen in Chapter VII, values are forever changing so that no value is forever fixed. This does not preclude the almost universal necessity of using other types of value by both buyer and seller to determine how much they can afford to give or take.

2. COSTS

A. Definitions. In business and accounting, *costs* or *costs of production* are defined as the prices paid for raw materials, labor, brains, incidental supplies, use of capital, and everything necessary to make a given product, a given volume of product, or a unit of product.

They are classified in ways to meet the needs of different manufacturing and business processes. In simplest terms, they are (1) cost of raw material; (2) cost of its manufacture and distribution. The latter may be broken down into *direct* and *indirect* cost. The largest direct cost usually is labor, including all human effort, whether in the form of brains, brawn, or technical skill. The chief indirect costs are those of plant construction and upkeep (the latter called *maintenance* cost), interest on borrowed money, taxes, and insurance. All costs which apply to the business as a whole and not to any particular operation are called *overhead* or *general* costs; the others are *operating* costs. Since overhead costs are more or less stable, they are often called *fixed* costs, the operating ones being called *variable* costs.

Cost records are usually kept for individual items as labor and raw material and also for units of finished product, as the entire cost of producing a finished automobile, or per thousand feet of lumber; these latter are known as *unit* costs. *Cost accounting* records and analyzes costs in order to improve efficiency and increase profits.

B. The Economic Nature of Costs. The various operations of manufacturing raw materials into finished products progressively increase the value of the materials from the beginning to the end of the process by removing unusable portions. Only 25 to 50 percent of

the volume of wood in standing trees is found in the ultimate products into which they are manufactured; yet its value in finished form is many times that of the original 100 percent.

This increase comes, as the economists put it, "from the application of labor and capital to natural resources." However, it can seldom be turned into cash until the entire process is completed. Iron ore from a mine is worth more than the same ore in the mine, but it can be sold only if some one will reduce it to pig iron. The smelting company performing this operation further increases its value but cannot realize on it unless manufacturers of finished iron products buy it, and so on until the product reaches the ultimate consumer who pays all the costs. *The entire profit comes from the final sale, no matter how it is split.*

This increase in value may be traced through every stage of the industrial process although the trail is often obscure. The manufacturing processes involved are frequently carried on by different industries, and what is finished product for one is raw material for another. The final product of the pulpmill is paper, which is raw material in the printing plant. Furthermore, each process may result in low-grade by-products of less value than the original raw material. Slabs and edgings seldom bring a price per thousand feet comparable to that of the original saw logs. Lastly, the units of measure of the product vary at different stages of the manufacturing process. Timber usually is bought on estimate when cut into logs by log scale, when it leaves the mill by lumber scale, and afterward by any number of special measures to correspond to its various uses. Pulpwood in the woods is measured by the cord; when it leaves the mill as paper, it is sold by the ton; and in the retail trade it sells by all sorts of special units.

In forestry, the application of labor and capital helps to increase the value of the trees in the forest just as it later does in the manufacture of forest products although the process is extended over periods of many years instead of a few months and the volume of the product is increased instead of diminished.

C. Unit Costs. Cost accounting is based not on the expense of operating a plant for a given time but on the cost of producing a given unit of final product, such as a pair of shoes or a thousand feet of lumber. This *unit* cost, compared to the selling price of the same unit, determines the rate of profit on that unit, just as the total production costs, divided into the total sales receipts, determine it for the business as a whole. Since most plants make more than one kind

of product and buy raw materials at varying prices, cost accounting enables them to keep track of rates of profit on all their transactions.

Only when lumbermen began to keep cost accounts on handling logs of different sizes did they discover that it frequently did not pay to cut the smaller trees in a stand even though they were large enough to yield merchantable material. Cost accounts showed that the cost of cutting, transporting, and manufacturing lumber from these trees was greater than its sale price (Chapt. X, Sec. 2).

Generally speaking, the more that machinery is substituted for hand labor, the higher the fixed and overhead costs per unit and the lower the labor costs, because extensive use of machinery requires increased use of capital and greater expense of management. However, total unit cost is generally reduced by such a substitution. Production is cheapest when a plant runs continuously and is as highly mechanized as possible. Many industries increase their capital investment in larger and more completely equipped plants for this reason as well as to accommodate expanding markets. But the law of diminishing returns (Chapt. X, Sec. 2) operates in the use of capital as well as in the use of labor, and a point in size is reached where increase in capital investment does not lower total unit production costs. Since few markets are stable enough for capacity operation at all times and occasional breakdowns and slow-ups are almost inevitable, few plants ever operate long at minimum cost. When all costs are known, it is possible to calculate the volume that can be produced most cheaply. Once a plant has reached this size, it should not expand further. If it has a constantly expanding market, it may be cheaper to build an additional plant instead of enlarging the existing one.

Productive capacity can be increased in some types of plants much more easily than in others. Where a number of similar machines are all making the same product, as in excelsior plants, it is easy to add more machines until the minimum cost is reached. In other plants, a single expensive machine regulates the entire volume of production, and other machines merely finish or assemble the product, as in a sawmill or an automobile factory. In the sawmill, the speed and capacity of the head saw regulates output; in the automobile factory, it is the assembly line. After the limit of capacity of the head saw is reached, it is possible to increase production only by adding another head saw and nearly a full complement of subsidiary equipment—in other words, by practically doubling the capacity of the plant, the capital investment in it, and the labor to operate it. In such cases, the only significant cost reduction comes in the spreading of overhead

or in the increased amount of product. For this reason sawmills are apt to be of standardized sizes, each size having more or less fixed limits of amount and cost of production. The same factors apply, although less rigidly, to pulpmills but not to planing mills, box factories, and other woodworking establishments where the machine units are small and their number can be added to without large increases in capital.

What are the factors of unit costs in the woods? Even with all possible mechanization in logging, a large amount of hand labor is required for felling and swamping and for handling small-sized products. Under a given wage scale, once a well-trained organization has been attained, these costs cannot be reduced by increase in output. Suppose an operation is producing only hand-hewn railroad ties. An average hewer can hew about so many a day. With a good crew the cost per tie will remain almost stationary. Variations will depend more on the nature of the stand, weather conditions, and so on, than on the number of men employed. If men are continuously added to the force, cost per tie probably will rise somewhat because of greater difficulty in directing them plus the difficulty of securing sufficient numbers of efficient workers. Even in mechanical logging, the size of the camp has to be kept to the maximum that one foreman can handle and to a man power that can be efficiently transported to and from work. Mechanization in forest industries is discussed further in Chapter IX, Section 10.

Unit costs generally are figured on the basis of (1) price paid for each unit of raw material; (2) labor charges for each operation upon it; (3) transportation, such as bringing logs from woods to mill; (4) unit overhead (total overhead divided by the total number of units produced). The cost breakdown may be even more minute and will vary with each type of product.

Unit costs in a given plant vary according to the percentage of its capacity which is being utilized. They tend to decrease as the output increases because it takes about the same overhead or fixed cost to operate a plant at full as at partial capacity and because this overhead, spread over a smaller volume, raises the cost of each unit. Interest on money invested in plant, insurance, and taxes continues whether the plant is running at full or partial capacity or is shut down. The increase in cost is not in direct relation to decline in capacity but tends to follow a curve similar to that shown in Fig. 13.

D. Time and Other Special Cost Units. The efficiency of operations may be compared by a record of the time necessary to perform them. For such comparisons man-time units are used, the time vary-

ing from an hour to a year. Thus, if an average man working under average conditions can plant an acre to pine seedlings in 12 hours, we may say that it is a 12 man-hour or, assuming an 8-hour day, a 1.5 man-day job. On this basis, if 100 acres were to be planted, it would require 150 man-days. If the planting season was limited to 15 days, obviously a 10-man crew would be needed.

Man-time units are particularly valuable in comparing the efficiency of work under different wage scales. The writer once had oc-

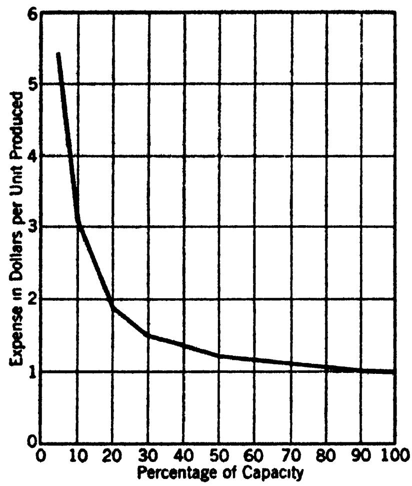

FIG. 13. Theoretical relations between cost of producing a ton of pulp in a mill when operating at different percentages of capacity. [After L. T. Stevenson, *The Background and Economics of American Paper Making*, p. 122, Harper and Brothers, 1939. Reproduced by permission of author and publisher.]

casion to compare Arab labor stripping cork in North Africa with French labor performing the same operation in southern France. The number of man-hours necessary per 200-pound unit of bark stripped from the trees and piled was about half as great for the French labor, but the differences in wage scales nullified this superior efficiency, and the unit cost was practically the same in both forests. On the other hand, time-unit comparisons between two relief organizations working on a similar forestry operation in neighboring American states showed that man-time units consumed on the forestry operation having the higher wage rate were greater. In this case it was a question of determining whether the higher paid labor was less efficient or whether there was a less efficient forester in charge. Since wage rates vary with time and place, time-units offer about the only possible measure of real efficiency of certain classes of operation.

Time units are also used for animal and power transport. Thus we speak of team-hours or truck-hours. In railroad transport the ton-mile is commonly used. In processes requiring the use of electric power, efficiency may be compared by the number of kilowatt-hours used to produce a given article.

E. Cost Distribution and Reduction. Cost of making the same type of product varies widely with time, place, type of plant, labor rates, quality of raw material, distance of plant from raw material and from market, and many other factors. Sometimes, as between competitive plants, costs may not differ much in total but greatly in detail; sometimes it is the reverse. In Chapter X we shall discuss these variations as they apply to the manufactured forest products; here we are concerned with certain general ways of reducing costs so as to increase profits.

For this purpose all sorts of devices are employed, such as mechanization, wage reduction, substitution of less expensive raw materials. All have their limitations. At any given time and place there is a point below which it is impossible to lower cost, either for individual items or for the total. The limits of mechanization are set by the progress of invention and the law of diminishing returns in use of capital. Wages can be reduced only so far, beyond which men will refuse to work or will work so badly that labor costs again increase. Prices for raw material are fixed by competition and other factors discussed in Section 3. Substitution of cheaper raw materials, carried too far, reduces the selling price of the final product. More complete utilization of materials may increase cost because of the greater output of labor and of mechanical power necessary. Fixed costs, involving interest payments on borrowed capital, are reducible only when operations are profitable enough to pay off indebtedness before maturity or are reducible by "refinancing" at lower interest rates—usually very difficult of accomplishment. It is sometimes done by liquidation through bankruptcy, in which some or all the owners lose their equity in the business, but the cost to the new owners is reduced.

Some companies, because of superior managerial ability, more favorable situation in reference to markets, raw materials, labor, supplies, or for other reasons, are better able to reduce costs than others. Plants may be divided into high-, medium-, and low-cost groups. Those producers having high costs are called *marginal producers* because, with decrease in sale prices, they may not be able to operate at a profit.

For a group of plants producing a standardized article, the ones that can produce and deliver it to the consumer at the least costs

should make, in theory, the highest rate of profit, although not necessarily the greatest total profit, since a smaller unit rate, applied to a larger volume of product, may yield a higher total return. A sawmill manufacturing 100 M. ft.b.m. per annum at a profit of $10 per thousand would make a total profit of only $1000, but one manufacturing 1000 M. ft.b.m. at a profit of $5.00 per thousand would have a profit of $5000. In many forest products industries the plants that can operate at the lowest unit costs are often the smallest because of their exceedingly low capital investment in plant and raw materials (Chapt. X, Sec. 5). If they wish to increase output on a large scale, the necessary capital investment would disproportionately increase their costs. This probably is not true of industry in general.

3. PRICES

To study forest economics without studying prices of forest products is to study it in an economic vacuum, but to understand these prices it is first necessary to discuss prices in general.

A. Kinds of Prices. Commodities usually have three prices, *mill, wholesale,* and *retail.* Those quoted in statistics usually are wholesale or mill prices. As mills are apt to manufacture many grades of the same product, the term *mill-run* price indicates the weighted average of prices of all grades. Lumber price statistics are usually for average mill-run or average wholesale prices.

Prices vary from temporary and deep-seated causes. The first are called *short-term variations* or *movements;* the second, *long-term* ones. Thus the price of lumber may be low at a time when building activity is slack, but its long-term trend may be upward, owing to increasing scarcity of stumpage. Long-term price changes greatly affect the fortunes of business not only as they vary in the same commodity but also as between different commodities. Since the value of money is constantly changing (Chapt. VII, Sec. 3), it is frequently desirable to change *monetary* prices to *real* or *adjusted* ones, the first being the prices as expressed in cash; the second, in terms of purchasing power or gold (Sec. 3*B*). Another way to compare prices is by turning them into percentages of a given price or the price at a given time. They are known as *index* or *relative* prices. Their use makes possible comparison between price movements of different commodities measured in different units (Sec. 3*C*). Sometimes both systems are used by making indices to real prices.

B. Real and Monetary Prices. Monetary prices may be converted to real prices by coordinating them either with shifts in value of gold

or other metallic unit on which a currency is based or with purchasing power as determined from an all-commodity index (Chapt. VII, Sec. 3, and Chapt. VIII, Sec. 3*C*). The second method is generally more useful. It consists in either the use of a purchasing-power index which is a reciprocal [1] of the all-commodity index (Fig. 11 was plotted from the purchasing-power index) or in the use of the commodity index

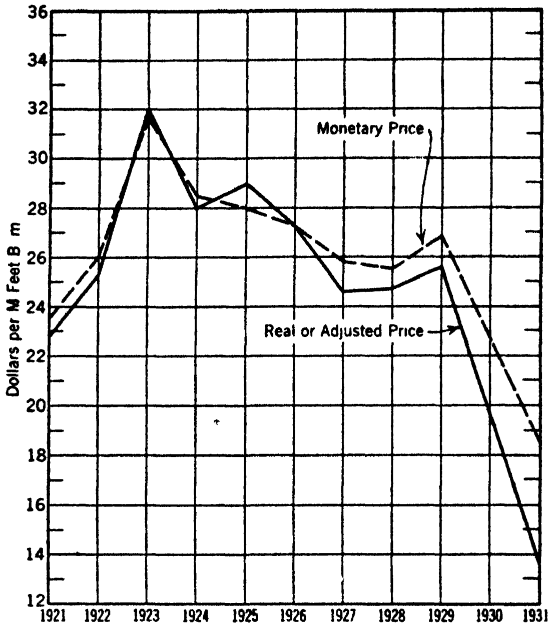

FIG. 14. Monetary and real prices of lumber in the United States (1921–1931) based on purchasing power of the United States dollar in 1926. Monetary prices were average values per thousands of feet board measure of lumber at the mill. [Data from United States Census of Manufacturing, United States Forest Service, and United States Bureau of Labor Statistics.]

itself. In the first case, divide the purchasing-power index into the price to be converted. In the second, multiply the price to be converted by the index. Thus in 1927 the commodity index on a 1926 base stood at 95.4, and its reciprocal, the purchasing-power index, at 104.82. The 1927 mill-run lumber price was $28.50 per thousand feet board measure. Using either method, the real price on a 1926 base was $24.61.

Figure 14 illustrates the relation between the monetary and the real price of lumber from 1921 to 1931. Observe that in 1923 and 1925

[1] The reciprocal of any number is obtained by dividing it into 1.

the real price was higher than the monetary because in those years the average of all prices, as shown by the all-commodity index, was higher than in 1926. In other years it was lower because the average of all prices was lower than in 1926. The spread between the real and the monetary price varied from year to year as the price of lumber went up or down in relation to the price of commodities in general. Consequently it is frequently sufficient merely to compare the course of the index prices of commodities under consideration with those of an all-commodity index and thus determine their relation to prices in general, as is done in Chapter XII.

C. Index Prices. By taking the price of a commodity at a given time as 100 and determining the prices at other times as percentages of it, one constructs a series of *index prices*. Suppose the prices of lumber for the years 1849, 1850, and 1851 were \$9.00, \$10, and \$11, respectively. If we let the 1850 price equal 100, the 1849 index price was 90 and that for 1851 was 110. Lumber therefore increased 20 points in price in 3 years. Suppose charcoal sold at \$0.12 a bushel in 1849, \$0.09 in 1850, and \$0.08 in 1851. The index prices of charcoal on an 1850 basis would then have been: 1849 equals 133; 1851 equals 89. In other words, while lumber prices increased 20 points, charcoal prices declined 44.5 points. In this example the 1850 year was taken as the *base year* for both series.

The earliest year of the series or one when prices were considered normal is usually taken for the base year. For the latter reason 1926 is frequently used. Unless the actual price for the base year is stated, index prices cannot be reconverted to cash prices; hence confidential price data may be used in their construction, as they are in the price indices issued regularly or periodically by various government departments, trade associations, newspapers, and commercial publications. An *all-commodity index* is constructed by combining the weighted averages of the prices of thousands of commodities.

Using index prices on the same base, we can compare the price movements of commodities as unrelated as scrap iron and ladies' underwear. Such comparisons, when made in graphic form, are particularly revealing. In Chapter XII much use is made of index graphs. Indices of movements in amount of production and production costs are constructed in the same manner as price indices.

D. What Determines Prices. There are two contrasting theories on what sets prices. One is that the utility value of an article to possible purchasers is just so much; hence, if it costs more than that to produce, no one will buy it, and therefore no one will produce it.

The other theory is that prices are fixed by costs of production and, whatever they are, people who can afford it will pay the price.[1] Each contains elements of truth. Neither considers all the factors involved. Prices are set by a complex of factors, the most important ones being supply and demand. Others are costs of production, competition, monopoly, general economic conditions, public regulation, popular customs and prejudices, and many less important factors. It is only by considering them all that one can understand what economists call "the phenomena of price."

E. Supply and Demand. These terms are used by economists in special ways and sometimes in more than one way. For some purposes, *supply* means *available* or *visible* supply at a given place and time; for others, it may mean the entire potential supply. The coal in the only retail yard in a town on a given day represents the supply available in that town on that day. The world's total coal supply is the estimated total amount of coal yet to be mined plus that mined but not consumed.

If a severe and prolonged cold wave threatens to exhaust the supply in the town and a break in transportation prevents its being replenished, all the coal in the world is not, from the point of view of the householders, supply at all. After they have burned all their coal, they "demand" more. But some of them may not have money to buy it. From an economist's viewpoint, only those who have the money participate in the demand. Probably the coal dealer will take advantage of the unusual conditions to advance prices. When the cold snap is over and the new supply arrives and has been distributed, the demand will fall off, and perhaps for months he can sell no more coal. The local demand has fallen to zero regardless of the supply. This represents the local and short-range working of supply and demand setting prices.

Local retail and even wholesale prices frequently are determined by conditions more or less similar to those above. Over long periods and large areas the factors of costs of production, competition, monopoly, and potential supply, substitution of other materials, etc., play a large part in determining prices, which in themselves affect demand.

F. Prices and Production Costs. The lumber dealer with a yard full of stock, facing a sudden decline in building operations in his community, may be obliged to sell his stock below what he paid for it and pocket his loss in order to get money to pay his current bills.

[1] See Chapter XII, Section 7, for discussion of these theories in relation to lumber prices.

In the face of an increase in building activity, his price goes up even though his previous price was well above his costs, but long-run prices must have some relation to production costs. Under private industry, goods cannot be sold continuously at less than cost. The lower the production cost, the less the product can sell for. If costs rise but selling prices remain stationary, profits will disappear. If demand increases, prices may be increased to meet increased cost. If prices go too high, the demand will decline. If demand, without regard to costs, falls to low levels, prices may likewise fall; and if demand falls to zero, production will cease. The tendency is for long-run prices to rise with increasing production costs and to decline with decreasing ones. Short-run prices are often unaffected by production costs.[1]

G. Competition. Competition may be between similar products or between dissimilar ones. As between producers of similar products, the producer whose costs are lower can undersell his competitors and still make a profit, or, if the competition is between two or more producers operating at the same costs and one producer is satisfied with a lower profit, he also can undersell his competitors. Therefore, under the theory of competition, prices should be set by the producers who operate at the lowest cost or are satisfied with the lowest margin of profit, but this happens only if these producers can meet the demand because the lowest-cost manufacturers are few in number (Sec. 2*E*) and may not be able to sell at such levels. After producers are sold out, prices will rise progressively so that even the highest-cost producers can "get into the market." As demand decreases, the reverse phenomenon takes place. In times of lowest demand, prices, so far as they are fixed by costs of production, are set by the lowest-cost producers; in normal times, by average-cost producers; and in times of great demand, by the highest-cost operators. In each case, the producers whose costs are out of line with prevailing prices stand to gain or lose according to the relationship of their costs to prevailing prices.[2]

Competition between dissimilar products may be *direct*, as between bricks and cement, or *indirect*, as between radios and washing machines. The latter have no relation to their relative costs of production and are largely independent of their respective selling prices but, since many households cannot afford both a radio and a washing ma-

[1] See also Section 4, paragraph 1.

[2] See Chapter X, Section 5, for discussion of this condition as it affects lumber mills of different types.

chine, tend to lower their individual sales. Competition of this form is really a struggle on the part of manufacturers of all products to secure the largest possible portion of the ultimate consumers' dollar. As applied to home-furnishing equipment, it probably has had its effect in reducing the sales of lumber. The home builder may prefer a small house, well equipped with gadgets, to a larger one without gadgets.

The competition of other building materials certainly has diminished the use of lumber regardless of its production costs (Chapt. XII, Secs. 5 and 6). The real competition here is between (1) the relative structural advantages of the different types of materials and (2) the relative total cost of construction of comparable buildings made from them. The prospective builder is interested in the total cost of building, not in the cost of individual items. Competition between lumber and other wood products which can be used as its substitutes in certain types of construction, as plywood versus matched board siding for interior finish, is of the same nature (Chapt. XII, Sec. 6).

H. Monopolies. A monopoly is an artificial scarcity designed to restrict production and hence raise prices. In the production of goods a monopoly may be created by control of raw materials, manufacturing facilities, transportation, sales outlets, or occasionally it may be created by governmental control at some stage in the production process (Sec. 3*K*). It is obvious that the monopolist need not concern himself particularly with costs of production in setting his prices. His only care is that they are not so high as to restrict consumption below the level of maximum profit. Every producer would like to obtain a monopoly. Occasionally, large concerns succeed over widespread fields and, more frequently, over small ones in restricted fields. Economic processes or governmental powers sooner or later break them down but often not before the consumer has suffered severely from the suspension of free competition. Monopolies also may come into being by groups of producers acting together to control production or prices—with or without formal agreement (Secs. 4 and 5).

The question is often asked whether there could be, is, or ever has been a monopoly of forest products in America. Since the most secure form of monopoly (other than a governmental one) is a raw material monopoly, it probably would be in the form of control of standing timber. It is scarcely likely that enough timber could fall into a single or even a closely associated group ownership to constitute a full monopoly. Nevertheless, the largest stumpage owners

were at one time accused of partial monopoly and price fixing (Chapt. XI, Sec. 3). Whether the charge was just or not it was made at a time when only virgin timber was considered merchantable. Today, with the increasing introduction of second growth timber on the market and the increasing importance of small mills (Chapt. X, Sec. 5), it does not seem likely that a real monopoly need be feared. Local monopolies or those based on special products or rare species may exist or may arise.

I. Effect of Abundance of Raw Material on Prices of Finished Products. The cost of raw materials is only the first item in the cost of producing finished goods. Prices for raw material vary as do other prices and for the same reasons, but the economic and business problems involved in obtaining them are frequently complicated. The process by which their prices are determined is described in Chapter XVIII. Here it is enough to state that (1) increase of raw material cost tends to force up prices of finished products so long as they cannot be compensated by decreased costs elsewhere in the production process; (2) increasing rarity or inaccessibility of raw materials tends to encourage the use of substitutes which finally may decrease the use of the original products and be an important factor in setting its price; (3) under competitive conditions the total supply of raw materials often has nothing to do with current prices of finished products. The price of gasoline goes up and down without consideration of the fact that each gallon consumed brings the world's total supply that much nearer exhaustion.

J. Effect of Business Cycles on Prices. Prices are finally set by the resultant of all the factors discussed under the previous headings—prices not only for individual commodities but also, to a considerable extent, for one commodity in relation to another. Under stable economic conditions prices remain reasonably fixed, but economic conditions do not long remain stable. Everyone is familiar with the business cycle which periodically raises havoc with the price structure. The periods of prosperity are accompanied by generally increasing prices, a lessening purchasing power of money, credit inflation, and wild speculation (Chapt. IV, Sec. 5). They culminate in crashes which, by destroying paper values and decreasing employment, sharply reduce demand that has already been reduced by high prices and cause prices to slump to low levels and finally to the point where the whole price structure breaks down (see also Chapt. IV, Sec. 6, and Chapt. VII, Sec. 3). The price structure must be painfully built up again during depression periods such as lasted from

the crash of 1929–1930 until the outbreak of the second World War. Both costs and selling prices generally tend to rise and fall in unison with fluctuations of the business cycle, but this does not follow for all items of each, so that some prices may be thrown out of alignment with costs and others may not be particularly affected.

K. Public Price Control. A government has many powers of price control. Under exceptional circumstances, as in war time, it may fix them or at least state maxima above which they may not go. At all times, in the interests of a healthy national economy, it may break up monopolies to keep prices from rising to injurious heights. When it charters monopolies, as of public utilities, it fixes maximum prices for the same reason. On the other hand it may operate in various ways, as the American government has acted in the matter of agricultural commodities, attempting to raise prices in the interests of a class of the population supposed to be in need of financial assistance. Finally, a government is a large buyer and seller of goods and services, in which capacity it influences prices in the same manner as other large producers and consumers.

In regulating some prices, a government, of necessity, affects others and thus affects the general price structure. The extent of its effects depends on the scope and volume of its action. They may not always be uniform and sometimes are seemingly at cross purposes, but generally tend to keep prices down to the benefit of consumers rather than up to benefit producers, and in general to equalize the extremes of the business cycle. Public price controls are generally disapproved of by private industry but, come peace or war, are probably a fixture in the economic scheme; their intensity may be expected to vary with circumstances.

4. PROFIT

Economists frequently state that, in the long run, goods sell at cost of production; they arrive at this conclusion by considering profit as a cost, representing the wages of capital and the reward of management. The accountant also must show profit as a cost in order to balance his books. For most purposes it is better to consider profit simply as the difference between cost and selling price. Profits are fundamentally in cash but may be reduced to a percentage of gain on invested capital. The latter process was discussed in Chapter VI, Section 8J, and Chapter VII, Section 7. The term *gross* profit indicates the total cash intake without deduction for costs involved. With those costs deducted, the term *net* profit applies. Unless otherwise stated, a profit is assumed to be net.

Sometimes it is useful to know whether a business is making money over and above its operating costs (Sec. 2*A*); hence the term *operating* profit. A business with a heavy debt load may make an operating but not a net profit. Profits usually are figured in terms of yearly operations (*annual* profits), sometimes for longer or shorter periods, and sometimes for the life of a specific operation. The *total profit* on a lumber operation cannot be determined until it is concluded, perhaps twenty-five years after it is started. In industrial operations, profits are often figured for comparative purposes on a unit basis, as so many dollars per thousand feet of stumpage purchased or so much on a ton of wood pulp sold.

In seeking maximum profits, a business may restrict expansion of production in order to keep up prices and make a high profit on a small output, or it may increase its production and try to market a larger volume by reducing prices. On the whole, the second course demands greater capital investment, greater managerial skill, and greater business risks. Obviously, if the largest number of businesses take the first course, prices will be maintained at high levels, but if they adopt the second course, competition becomes keen and will force them down. The social repercussion of either policy, carried to its extreme, is far-reaching.

5. SOCIAL SIGNIFICANCE OF PRICES AND PROFITS

The social effects of high-price restricted production, on the one hand, and low-price large-scale production, on the other hand, can be illustrated by sample cases. Assume that all the lumber mills in the United States decided on a high-production, low unit-profit basis. The price of lumber would immediately fall. The price of housing—in so far as it is determined by the price of lumber (Chapt. XII, Sec. 4)—would drop so that many more people could own their own homes, and rents would be cheaper. Carried far enough, many people might be able to build homes who could not afford to maintain them, and many houses ordinarily rented would be idle. Furthermore, in the long run, such a policy would lead to forest destruction, soil erosion, sweated labor, unemployment, ghost towns, and later to extremely high prices for inferior lumber. It is difficult to see any ultimate social advantage in unrestricted competition on a high-production, low unit-profit basis for not too abundant natural resources.

On the other hand, the policy of restricted production and high unit profits also has social disadvantages, for it maintains prices at levels which do not permit goods to be purchased by all who need them. Within an industry it tends to create monopoly, often with-

out any formal agreement between producers. At one time the automobile manufacturers operated on this basis. The motor car was a luxury. A manufacturer, sensing the possibilities of huge rewards from mass production and sales at popular prices, paved the way to all the social advantages that widespread use of motor vehicles has brought. A policy of severely restricting lumber production to secure high unit profits would make lumber a luxury product and deny the advantages of its use to large classes of the population and, in the end, have an unfavorable effect on the industry (Chapt. XII, Secs. 6 and 7).

It is claimed that, in the long run, the capitalistic system (Chapt. IV, Sec. 8) operates more largely for the benefit of producers than consumers because of the more common tendency of industry to maintain high prices on a low-production basis than to drop them on a high-production basis. Moreover, it is a common observation that vast numbers of people live without many things needed to make existence tolerable, let alone comfortable. Therefore, the present system is often described by its critics as an *economy of scarcity*, characterized by *production for profit*, and contrasted unfavorably with one where necessities, at least, could be produced and sold at prices low enough to make them available in sufficient quantity to satisfy everybody's needs. They refer to such a system as an *economy of abundance*, characterized by *production for use*, under which, however, destruction of natural resources would be controlled even at the expense of immediate consumption.

Few would deny the social advantages of a system under which essential goods would be available for all. All democratic nations are struggling to attain this ideal. No one has produced a satisfactory blueprint, much less a complete working drawing of such a society. Various suggestions and experiments have been made. Those most popular in America concern raising the purchasing power of lower income groups by higher wages, various forms of subsidy to alleviate excessive competition and resulting price collapses, and high taxes on excess profits and on great private fortunes. It is not our business to discuss either the possibilities or the methods of attaining an economy of abundance, but in Chapter IX, Section 7, and in Part III we shall discover that the idea has many implications for forestry.[1]

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[1] Thorstein Veblin, *The Engineers and the Price System*, B. W. Huebsh, Inc., New York, 1921. Chapters I, II, and III are a good general reference to the material in the first part of this section.

Stuart Chase, *The Economy of Abundance*, 1934, covers the second.

PART II

SPECIAL ECONOMIC FACTORS IN FORESTRY

CHAPTER IX

ECONOMIC AND SOCIAL VALUE OF FORESTS

Every economic value has social significance and every social value has an economic aspect. In 1937 the lumber products produced in the United States were worth $848,481 million, but this did not measure their social value. In the same year the national forests entertained 40 million recreational visitors. This has an enormous economic significance not expressible in dollars. Instructive as are statistics of values and quantities, the primary purpose of this chapter is to show how forests function in the American economic and social scheme.

1. FOREST VALUES

Forest values are the sum of those of its various products and services, which fall into three major groups: (1) wood and wood-derivative products, (2) wildlife and such non-arboreous plants as grow in forests, (3) intangible products and services summed up in the terms "forest influences" and "environmental values." Group 1 includes lumber and all other wood products in which the structure of the wood is not changed. Wood-derivative products include wood pulp, naval stores, and other chemical products extracted from wood as well as from barks and fruits. Group 2 includes all forest-inhabiting animals having significance from a human point of view and all vegetable products of non-arboreous nature, such as forage, various edible and medicinal plants, and economically valuable mosses.[1] Group 3, the environmental values, includes the values which prevent or limit erosion, mitigate floods, conserve water, provide recreation and military defenses.

From an environmental viewpoint the standing trees are the key value of the forest. Other values are derived exclusively from the

[1] Except for forage the total value of non-arboreous vegetation is relatively small, but locally it sometimes may be of considerable importance. It is estimated that in 1937 about a million dollars' worth of Spanish moss was collected in Louisiana. *1939 Southern Forestry Notes,* 29, United States Forest Service, New Orleans, Louisiana.

removal of physical products[1] but, unless this removal is carried on in such a way that the forest renews itself, *all* values are destroyed or impaired. Whatever the temporary economic gain, forest destruction is justifiable only when the land has greater permanent value for other uses.

The relative importance of the different values varies with the character and location of the forest and with the stage of culture of the people who use it. In earliest history the chief forest value was derived from its wildlife which provides both food and clothing.[2] As civilization advanced, wood products became increasingly valuable, and for many centuries forest value was considered almost synonymous with timber value. Only recently have environmental values become fully understood, and it took a lot of forest destruction to drive home their importance. Perhaps even yet the lesson has not been fully learned. It cannot be said that these values are greater than those of wood products, but there are places where they may be.

2. FORESTS AND OTHER NATURAL RESOURCES

Forests are linked, both in production and use, with soil, mineral, and agricultural resources, without reference to which they may have but little value. When all these resources occur in correct proportion in a region, it may be self-sustaining. Since this seldom happens, there is a vast interchange of products between regions, nations, continents, and climatic zones, each desiring to trade its surplus products for those it lacks. Civilization depends upon this exchange.

If country A produces timber but not wheat, and country B produces wheat but not timber, and something stops their exchange, lumberjacks and mill hands are thrown out of work in the one country and farmers cannot sell their crops in the other.

Forest products bulk large in world trade, both in heavy shipments of the common woods and in smaller shipments of special products. They are smaller, however, than they would be if forests were not fairly abundant and if the need for their products were less urgent than for food and some other supplies. The region importing wheat must eat, but the one importing lumber need not build new barns every day and can even build them of other material. Nevertheless, when forest products are complementary to some other raw material

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[1] The term "forest products" is sometimes used to cover the values in all three groups. In this text it is generally restricted to wood and wood-derivative products.

[2] This holds true with primitive people, untouched by civilization, even today.

or are necessary to the completion of some finished article, a stoppage of forest imports is immediately critical. Coal mines are soon closed in forestless regions if the importation of mine-props is stopped (Sec. 6*D*).

Even environmental products enter into this exchange. Water power and pulpwood are both forest products. Combined they may be shipped as in newsprint paper or the power may travel alone via high-tension line. Scenery cannot be exported but people go to it. The combination of forest and mountain scenery in Switzerland entices tourists from everywhere. Catering to them is a major Swiss industry. The money they spend there is called an *invisible* import, the visible scenery being economically an *invisible* export.

A region's imports of products which it needs or desires is limited by its exports to the amount it can pay. Regions and countries, poor in natural resources, do not provide extensive markets. Whatever the needs of Greenland for timber, its imports are low. What has she to export in large volume? World trade, after all, boils down to barter of commodities.

3. ECONOMIC REGIONS

The earth is divided into great regions, based on the nature of their primary natural resources. Lesser differences in nature of resources break these major regions into smaller and smaller ones. The major ones are determined largely by climate, topography, and the distribution of minerals, the last often without relation to the others. On a purely climatic basis the major divisions are between forests, natural grasslands, and deserts. Large areas of both forests and grasslands are now given over to agriculture, and the remaining natural grasslands are used chiefly for livestock production.

To these major regions are added the industrial ones, which have developed in places favored by geography for receiving and transshipping goods and for having power resources and population aptitudes. They are usually near navigable waters. England, with its coal resources, strategic situation in reference to waterways, and energetic population, was the first modern industrial region. Others grew up later in western Europe, in northeastern United States, and to a lesser extent elsewhere. They live by manufacturing finished goods from imported raw materials and by exporting the goods they do not need. Often the finished products go to the region that produced the raw materials; witness the old story of the cow country shipping cattle and eating tinned beef.

The regions that produce raw materials are called *raw material* or *producing* regions.[1] The industrial regions are also known as *consuming* regions. If a region's primary source of income is from farming, it is said to have an *agricultural* economy; if livestock production, a *grazing* or *pastoral* economy; if forests, a *forest* economy. If it lives by manufacturing, it has an *industrial* economy. If it has more than one economic base, as agriculture and industry, it has a *mixed* economy. The great economic regions have little relation to national boundaries. The imaginary line that separates Canada from the United States cuts through two major forest, one great agricultural, a grazing, and an industrial region. Such political divisions do not facilitate interchange of products, which is the lifeblood of commerce and industry.

The lasting economic success of a region depends upon its skill in utilizing its natural resources on a permanent basis. Failure to conserve them results in worn-out soils, slag heaps, stumpland, eroded hillsides, choked-up harbors, abandoned cities, declining population, and desperate poverty. Forests are not the only natural resource which has been unintelligently handled. All are intimately related. Our chief concern is with the forested regions and with the economic part that forests play in regions where they form a partial economic base. After a brief survey of the major forest regions of the world, we shall study the various types of forest economies.

4. FOREST REGIONS

The world's major forest regions are in the north temperate zone and the tropics. The former are at present much the more valuable because they are generally more accessible (Chapt. X, Sec. 2) and contain more useful species. Consequently, except for remote regions, notably Siberia, they have been heavily exploited, and large areas have been transferred to agricultural and other uses. Tropical forests, while less extensive than popularly supposed, cover vast areas in South America, Africa, parts of southern Asia and its adjacent islands. They are far more varied than those of the north temperate zone but unite in having relatively few species suitable for general use although some are highly valuable for special purposes. Otherwise, tropical

[1] Although the primary processing of raw materials to fit them for transport must take place at their source, such processing does not make the region an industrial one. There is a worldwide tendency for raw material regions to develop their own industrial centers. The fact that industrial regions do not favor this course is a contributing cause of present world conditions.

forests have been little exploited although their area has been diminished, especially in southern Asia and its neighboring islands, by agricultural clearing. Some think that forest exhaustion elsewhere plus technological progress will make tropical forests eventually the more important. The many factors involved make prediction hazardous. The south temperate zone forests are relatively small and scattered. Except for special products, they scarcely figure in world trade. These regions import most of their forest product requirements from the north temperate zone.[1]

TABLE 4

LAND USE IN THE UNITED STATES [1]

	Millions of Acres	% of Total Area
Commercial forest	495	26
Non-commercial forest [2]	120	6
Total forest	615 [3]	32
Pasture and range	696	37
Farm crops	413	22
Other land [4]	179	9
Total	1903	100

1 Continental United States exclusive of Alaska. *A National Plan for American Forestry*, Senate Document 12, 73d Congress, 2d Session, Washington, D. C., 1933, commonly called and hereafter referred to as Copeland Report.

2 See footnote 1, table 5.

3 The United States Forest Service, in its statement *A National Forest Economy*, 1939, gives the total forest area as 630 million acres, probably by considering larger areas of abandoned agricultural land as forested than is done in the Copeland Report. It is difficult to define forest boundaries exactly when they merge with open lands.

4 Urban and waste land, highways, residence property, etc.

The forests of the United States divide themselves into two great regions, those east and those west of the Great Plains (Frontispiece). The eastern forests originally were practically continuous but now are greatly reduced in extent owing to agricultural and other clearing. Their virgin timber now is almost exhausted and the second growth on cutover land and abandoned farms is mostly young or of relatively poor quality. The western forests were less extensive, being largely mountain forests separated at lower altitudes by vast areas of open country where rainfall is too scanty for tree growth. The best timber

[1] For detailed descriptions and statistics of the world's forest areas see R. Zon and W. N. Sparhawk, *Forest Resources of the World*, McGraw-Hill Book Company, New York, 1923.

is on the Pacific slope, that in the Rocky Mountains being mostly slow growing and of small size. The Pacific forests now contain the best timber in America.

The forest products of the great regions are not entirely interchangeable. Those of the West contain no hardwoods valuable for furniture or other special uses. Although the eastern forests contain conifers useful for general construction, they are no longer procurable in such large dimensions as those from the Pacific Coast. Approximately one-third of the United States is forested. Comparison with other major land uses is made in Table 4.

Table 5 gives the commercial area and volume of saw timber for the major subregions of the great eastern and western forest regions.

TABLE 5

AREA AND VOLUME OF SAW TIMBER IN MAJOR FOREST REGIONS OF THE UNITED STATES [1]

Region	Commercial Area [2]	% of Total Commercial Area	Volume of Saw Timber [3]	% of Total Volume
New England	27,273 [4]	5	57,875	3
Middle Atlantic	27,139	5	26,150	2
Lake	55,895	11	35,887	2
Central	64,249	13	34,622	2
South	190,758	39	199,297	12
Eastern forests	365,314	73	353,831	21
Pacific Coast	66,685	14	1,041,628	62
North Rocky Mt.	32,329	7	146,388	9
South Rocky Mt.	30,570	6	125,956	8
Western forests	129,584	27	1,313,972	79
Grand Total	494,898	100	1,667,803	100

1 Copeland Report, pp. 122 and 176.

2 Commercial forests are defined on p. 121, Copeland Report, as areas "which may be capable of producing timber of a commercial quantity and quality under present or reasonably conceivable future conditions."

3 Millions of board feet.

4 Millions of acres.

Manifestly the important conclusion from Table 5 is that nearly three-quarters of the forest land is in the East, but about the same proportion of the saw timber is in the West, chiefly on the Pacific Coast, which produces about one-third the lumber used in the whole country. The greatest area and volume of the Atlantic forests lies in the South, which cuts another third. On the other hand, the Northeast

is the most densely populated and the largest consuming region of America; it produces less than 4 percent of the total cut. Without regard to special kinds of timber or other forest products, it is evident that from a geographic point of view our forest economy lacks geographic balance. This is considered further in Chapter XII.

5. FOREST ECONOMIES

Forest economies may be full or partial, temporary or permanent. This section concerns forests as the chief economic base of a region. Section 6 considers their functioning as a partial one. A forest economy may be based on wildlife, timber, recreation, or all in combination. Historically forest resources have usually been exploited in that order. When all are exhausted, either some other base or bases must be substituted or, if there are no other resources, the region becomes economically prostrate (Sec. 12). A full forest economy, whatever its base, must inevitably export most of its products and so is largely dependent on imports for most of its material needs. It is therefore more subject to economic vicissitudes than regions having diversified economies.

A. Wildlife Economies. The temporary wildlife economy which preceded that of all other uses of American forests (Chapt. XI, Sec. 1) took refuge in a permanent form in the non-commercial forests of northern Canada. This vast region lives largely from its fur trade. Other examples are northern Siberia and parts of tropical Africa. Such an economy cannot support a large population on a high cultural or economic level. Furs usually are collected by natives who barter for supplies from traders who often represent absentee interests that reap large rewards. The Hudson's Bay Company, which has had almost a monopoly in northern Canada, is one of the world's great corporations, dominating the region in which it operates. The similar forests of interior Alaska likewise are chiefly valuable for their fur catch. In 1939 the Alaska crop was estimated to be worth $2 million.[1]

Wildlife is a renewable resource which can be "mined out" and often has been. Conservative cropping, if not sustained yield, has characterized Canadian operations. The combined efforts of the European powers have not prevented serious depletion of African wildlife resources. The possibilities of fur resources are elemental in other forms of forest economies as is indicated by the average annual fur catch of

[1] Not including fur seals, hardly to be classed as forest animals. Figures from United States Fish and Wildlife Service.

continental United States, estimated[1] at $50 million, even though a large portion of the crop comes from non-forest-inhabiting species (see also Sec. 5D).

B. Timber Production Economies. Such an economy requires a considerable forest area physically and economically suited to exploitation (Chapt. X, Secs. 2 and 3). Other resources and industries, if any, are facilitating or secondary. The farms feed the workers in woods and mills; iron works manufacture logging and milling equipment; transportation lines are laid out to move timber; shops and amusement facilities cater to workers in the main and subsidiary industries. Directly or indirectly, the bulk of the population is dependent on the forest, and the public services are supported by taxes on them, their products, and the people exploiting them (Sec. 9).

Temporary and permanent forest economies have quite different social and economic characteristics. The social structure of a temporary forest economy usually is characterized by nonresident ownership, a liquidation philosophy, and migratory labor. Everyone expects to move on.[2] A permanent forest economy has a settled character. Workers need migrate no longer. A community, mostly of single men living in camps and shack mill towns, taking their pleasures where they find them, gives place to one of families having a more normal life in settled communities. Existence is from generation to generation, not from payday to payday.

The forests of the Pacific Northwest are still in the primary stage of exploitation, and it is generally recognized that large areas in those states have few other resources. Only the future can tell if their present economy will be permanent, but it is an example of the significance of a large-scale timber-production economy. In 1937 Washington and Oregon alone furnished nearly 36 percent of the lumber produced in the entire United States and employed 26 percent of the country's wage earners in the primary forest industries (Sec. 9). Within the two states 64 percent of the labor in manufacturing was employed in these industries. Their total salary and wages were over $141 million, or 56.6 percent of all industrial wages and salaries. The

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[1] United States Fish and Wildlife Service.

[2] Steward H. Holbrook, in *Holy Old Mackinaw—A Natural History of the Lumber Jack,* The Macmillan Company, New York, 1938, has dealt with the picturesque side of the various temporary forest economies.

G. R. Leighton, in "Seattle, Washington, The Edge of the Last Frontier," *Harper's Magazine,* March and April, 1939, has described its more fundamental economic features in the Pacific Northwest.

following tabulation relates the value of forest products to other raw materials and manufactured products in the two states in 1937.[1]

Forest products	$477.475 million
Agricultural and livestock products	306.000 million
Mineral products	33.286 million
Fishery products	9.832 million
All non-forest manufactured products	561.307 million

That the value of other manufactured products exceeds somewhat those of the forest-product group is not of particular significance since practically none of them is a primary industry. They vary from food packing to millinery.[2] The labor in transporting and selling forest products is not included, but the amount so employed is large wherever forest products are manufactured (Sec. 9).

America has seen many temporary forest economies. Some have given place to fields and farms, some to industrial areas, and some to desolation. Those regions where forests are being constructively exploited are tending to take on multiple-use characteristics (Sec. 5*D*).

C. Recreation Economies. A forest recreation economy is one where the major use of the forests is for recreational purposes and its inhabitants make their living from the recreationalists. Generally it requires a forest area having other scenic and recreational features, as lakes, rivers, or mountain peaks. To be permanent it is necessary that cutting either is restricted, so that scenery is not damaged, or is entirely prohibited (Chapt. XVI, Secs. 2 and 4). Wildlife is an asset in recreational forests, but for aesthetic or sporting rather than direct economic reasons.

Like any other form of economy a recreational one requires a market which can develop only when (1) large numbers of people have the means, leisure, and an interest in the out-of-doors; (2) the forest is within economic reach and has facilities for caring for large numbers of visitors. A remote wilderness, regardless of its romantic appeal to the few who are both rich and hardy, cannot serve as the basis for a prosperous and exclusively recreational economy.

The forest areas given over entirely to recreational economies are much smaller than those devoted to the other main types of economies and are generally, though by no means always, surrounded by forests

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[1] *1937 Census of Manufactures* and the *1939 Statistical Abstract*, United States Department of Commerce, Washington, D. C.

[2] See also discussion of similar statistics for Maine, New Hampshire, and Vermont (Sec. 5*D*).

used largely for other purposes. They are very diverse in character. Some are publicly sponsored, as those surrounding national and larger state parks (Chapt. XVI, Sec. 2*C*). Others are based on private ownership of the estate type (Sec. 6*E*).

Since recreation is paid for from surplus funds, it has the economic aspects of luxury products and is severely curtailed in depression times. Consequently, a recreational region is very sensitive to prosperity conditions. Since recreational use generally is seasonal, the local population, if not provided with other employment, often has a hard time making ends meet (Chapt. XVI, Sec. 2*C*).

D. Multiple-Use Economies. A permanent forest economy usually is based on all three main types plus those discussed under Partial Forest Economies (Sec. 6), even though not all uses may be equally important. It may grow out of definite planning or from a combination of favorable circumstances and conservative use. If it is to function at its maximum, planning is essential (Sec. 7 and Chapt. XV).

Partly owing to a lack of other resources, partly as a result of favorable circumstances and by virtue of a degree of informal planning, northern New England and northeastern New York have developed an economy having many characteristics of permanent multiple use. Private forest ownership is divided among large-scale industrial, farm, and recreational type of ownership. Public forests are less important than private, except in the Adirondack region of New York, where they are of the recreational type. The region covers 35 to 40 million acres, of which about 80 percent is forested.[1] It is still producing timber in quantities though on a declining scale after over a century's continuous exploitation (Chapt. X, Sec. 6). Maine, New Hampshire, and Vermont only of all northeastern states produce more lumber than they consume,[2] and their consumption is somewhat above the national average. They are able to export some timber,[3] but their most valuable forest product is pulpwood.[4] Woodworking and other secondary forest industries are also important.

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[1] Descriptions and statistics, unless otherwise noted, apply only to northern New England.

[2] R. V. Reynolds and A. H. Pierson, Tables 3, 6, 11, 16, 18, and 24, *Forest Products Statistics of the Northeastern States*, Statistical Bulletin 70, United States Department of Agriculture, Washington, D. C., 1940.

[3] Reynolds and Pierson, Table 18, *Lumber Distribution and Consumption, 1936*, United States Forest Service Forest Research Project, Report 1, Washington, D. C., 1938.

[4] The region along with nearby states is one of the most important pulp-producing and paper-manufacturing regions of America (Fig. 36).

The forests have an important function in regulating the flow of the rivers into the Atlantic seaboard and the St. Lawrence valley for the generation of electric power used by the local forest and other industries and exported to the industrial regions to the south. Taken with its adjacent seaboards, this region is a vast playground for the whole United States. Maine and the Adirondacks with their large wilderness areas cater to canoeists, wilderness hikers, big-game hunters, and off-the-beaten-track fishermen. New Hampshire and Vermont cater to the mountain climbers and trail hikers and other less active pursuits. Hotel, tourist and recreation camp operation ranks as an industry. Almost every farm house and many town homes "take in tourists." [1]

The average number of recreational visitors in recent years is estimated at 3.6 million.[2] This doubtless includes some duplication. The estimated sum spent by the tourists was about $200 million,[2] of which $100 million perhaps is properly ascribable to forest recreation exclusively. As nearly as can be determined from figures supplied, the state governments received in 1939 about $300,000 for nonresident hunting and fishing licenses. There appear to be about 3500 licensed guides who earn from $4.00 to $6.00 a day [3] during the "season." These men often do commercial trapping in the winter months.

About 20 percent of the industrial labor is classified by 1937 census reports as being employed in forest industries,[4] but this does not include either those transporting products or farm labor doing woods work in the winter. The following tabulation [5] shows the relative value of forest products to other natural resources and manufactured products for the year 1937 for Maine, New Hampshire, and Vermont.

Forest products	$192 million
Agriculture and livestock products	137 million
Mineral products	12 million
All other manufactured products	654 million

The census does not account for forest products, such as poles, posts, and firewood, or for production of the very small mills, the inclusion

[1] A. S. Carlson, *Economic Geography,* July, 1938, discusses in detail the recreational industry of New Hampshire.

[2] Various official and semi-official estimates.

[3] Include the Adirondack region in New York.

[4] *1937 Census of Manufacturers* and the *1939 Statistical Abstracts,* United States Bureau of Census, Department of Commerce, Washington, D. C.

[5] *Ibid.*

of which would raise the forest-product total. The other manufactured products come mostly from southern New Hampshire and southwestern Maine which lie outside the main forest belt. If a full total of the value of the products and services of forests in this region could be arrived at, including, as it would have to, recreation, wildlife, water power, and the value of forest products not shown above, it would add many million dollars to the $192 million shown.

Until the necessary steps are taken to put the forests of this region on a sustained-yield basis (Chapt. XV), one cannot say that its forest economy is permanent, but its relative success in diversified long-term utilization gives an inkling of what a permanent forest economy could mean to large areas in other parts of America.

6. PARTIAL FOREST ECONOMIES

Forests may play an important and at times a key role in mixed economies of various sorts. The following five types are the most common.

A. Forest and Water-Use Economies. This title is applied to an economy under which the water collected or controlled by a forest plays an important role in power production, navigation, and furnishing domestic supplies or irrigation. It differs somewhat between regions where the forests are close at hand, as in the eastern United States, and where they are far distant from the place of use, as in most of the West. But whether the water is used near its source or far away, the region consuming it is linked economically with the region producing it (Chapt. XVI, Sec. 1). This dependence is greatest in the water-consuming regions in the West situated in semi-arid regions where local supplies are scanty; it is least in humid regions of low relief (Fig. 15).

The importance of forests and water-use economies in the humid eastern United States is indicated by the fact that in 1928 the total land and water area of the small state of Connecticut, owned for public water supply, was 105,249 acres. This was 3.2 percent of the total area of the state. Of this 105,249 acres, only 13,482 acres were water covered; the remainder being forested, water-catchment area. At that time it was estimated that the total area of land and water surface needed for public use probably would eventually be doubled.[1] The

[1] P. L. Buttrick, *Public and Semi-Public Lands in Connecticut,* Bulletin 49, pp. 853–888, Connecticut State Geological and Natural History Survey, Hartford, 1930.

importance of a forest and water-using economy on the Pacific Coast is sufficiently clear from Fig. 16, which shows the forest areas of California classified by water uses derived from them.[1] For the country as a whole, it is estimated that 465 million out of the 630 million acres of forest in the United States have an important function in either furnishing or controlling water.[2]

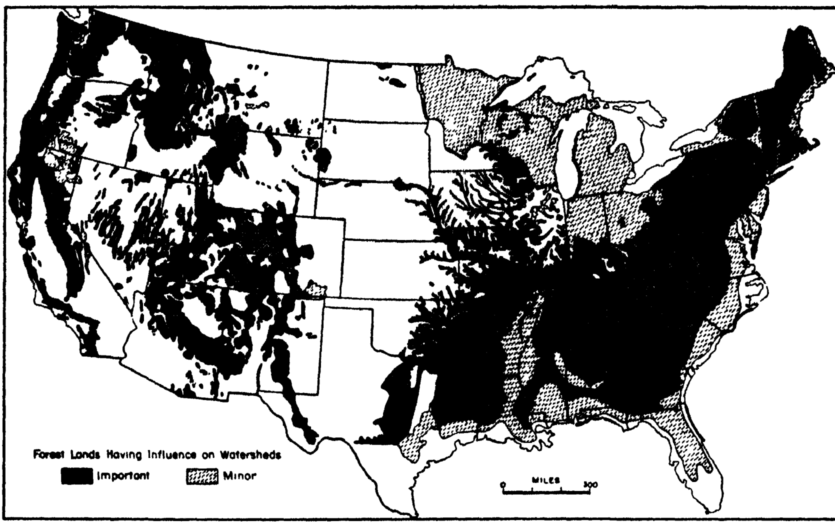

FIG. 15. "The extent to which forests having an important influence on streamflow and erosion blanket most parts of the country is shown in the map. The one-fourth of the forest having a minor influence occupies only a relatively small area, much smaller than indicated because the forests that remain are not continuous. But the streams from the area having an important influence flow through nearly every other part of the country, so that practically our entire population is directly or indirectly concerned with the watershed benefits that the forest can render." [*A National Forest Economy*, p. 79. Courtesy, United States Forest Service.]

B. Agricultural and Forest Economies. Such economies exist in two forms: (1) irrigation agriculture, based on waters derived from forest areas, and (2) forest production on non-agricultural soils which occur intermingled with the agricultural ones in farm regions. This is usually called *farm forestry*.[3] Irrigation agriculture is common in

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[1] *A National Forest Economy*, p. 73, United States Forest Service, 1939.

[2] *Ibid.*, p. 70.

[3] For a full discussion see R. H. Westveld and R. H. Peck, *Forestry in Farm Management*, John Wiley & Sons, New York, 1941.

the West, where in many semi-arid sections agriculture depends upon irrigation and most of the water is derived from forest areas (Sec. 6*A*). In 1929 irrigation agriculture in the West, largely or wholly dependent upon forested watershed, produced $9 million in crops and represented an investment of $6 billion.[1]

The use of non-agricultural land in farm regions for forests may take the time-honored form of the farm woodlot which supplies fuel and other products for farm use and occasionally a surplus for sale.

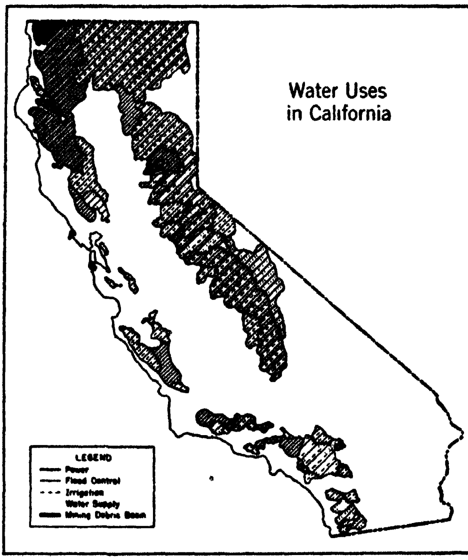

FIG. 16. "In no other State is water more nearly the key to all other development than in California, and perhaps in no other State is the assurance of the maximum amount of usable water more dependent on the forest. When the various forms of water use or services are superimposed on a map of the forest areas of the State, the part of the forest area that serves only one water use is shown to be amazingly small." [*A National Forest Economy*, p. 71. Courtesy, United States Forest Service.]

Or it may be carried much further by the systematic cultivation of forests on large areas of submarginal farmland by farmers or others, on a commercial basis. The opportunities for this in large areas in the East and South appear to justify a belief that forests may become an even more important element in agricultural economy than they now are (Chapt. XIX, Sec. 4*A*).

[1] *A National Forest Economy*, p. 73, United States Forest Service, 1939.

The 1935 United States Census figures[1] show that the total area of farm woodlands in that year was 185,474,965 acres, an increase of 23.7 percent over the corresponding figures for 1930.[2] In the latter year the average woodland acreage per farm for the entire country was 27 acres. The percentage of area in woodland per farm for the whole country amounted to 17.59. The total value of farm forest products was estimated at $169.075 million in 1935.[3]

C. Forest and Grazing Economies. Wherever forests produce forage that can be economically harvested by domestic livestock without damage to the timber growth or other resources, a combined forest and grazing economy is possible. Grazing under such conditions is usually conducted as an enterprise unconnected with agriculture, being called *range grazing*. In this way it is carried on over approximately 150 million acres of southern pine forests and on nearly twice that area in the western forests.[4]

In the South the stock remains on the same range all the year; in the West this is generally impossible. The herds usually summer in the mountain forests and winter below in the open country, which, owing to heat and drought, will not support large herds in the summer. Consequently, the summer forest range gives an added value to the open winter range and the livestock forms an economic link between mountain and plain, forest and grassland.

Much of the western forest range is in national forests or in other forms of public ownership. The annual receipts to the government from grazing fees on the national forests in recent years have averaged about $1.5 million. Advantageous as is a combination of forestry and grazing, it is exceedingly dangerous unless carefully controlled to prevent overgrazing, which is fatal to the range and the forest alike.[5]

D. Mining and Forest Economies. Several possible relationships may exist between forest and mineral resources when they occur in the same region. (1) They may be destroyed to get at the ore bodies that lie close to the surface, as by strip mining in the iron ranges of Minnesota, or by other operations incident to mining processes, as smelting operations that release gases toxic to vegetation, as at Duck-

[1] W. R. Mattoon, *Forestry and Farm Income*, p. 3, Farmers' Bulletin 1117, United States Department of Agriculture, Washington, D. C., 1938.

[2] L. Solin, *A Study of Farm Woodland Cooperatives in the United States*, p. 23, Technical Publication 48, New York State College of Forestry, Syracuse, 1940.

[3] Report of the Chief of United States Forest Service, Washington, D. C., 1937.

[4] Copeland Report, Vol. I, p. 529.

[5] P. L. Buttrick, "The Forester or the Shepherd," series of articles, *American Forests and Forest-Life*, Vol. 32, Nos. 386–390, February–June, 1926.

town, Tennessee.[1] (2) They may be cut off to furnish fuel for the smelting of ores as was common before the introduction of coal and coke for this purpose. (3) They may be used as a steady supply of mine timbers for deep mining. (4) Mining and forest industries may be conducted in the same region without reference to each other except that the forests supply necessary timber.

Destruction of forests for strip mining may or may not be economically justified, dependent upon all values involved, but the time should have passed when smelter-fume destruction of forests or other vegetation can be justified on any basis.

The use of forests in a mining region as a perpetual source of mine timber is the ideal relation in that it provides an outlet for local forest products and reduces the cost of mining operations. The depleted forests of Pennsylvania and West Virginia are still able to supply most of the mine props for the coal mines of those states, but the even less well forested states of Ohio and Illinois are obliged to import a larger portion of their mine props [2] at a presumably higher cost. Every purchaser of English coal for a century has paid or has more than paid his share of import cost of pit props, as they are called there.[3] Nevertheless, it must be remembered that mine props are a low-grade product, obtainable from thinnings. A type of forest management, content to utilize the forest for a low-grade product only, contributes less to local economy than one cultivating them for high-grade products and utilizing the poorer ones for lower-grade uses. The use of anthracite coal lands in Pennsylvania for forest crops besides mine timber is under study by the United States Forest Service.

In 1935 the total value of mine timbers, both round and sawed, produced in the United States was estimated at $27.458 million; the three largest consuming states were Pennsylvania, West Virginia, and Kentucky. About 83 percent of the timber used was in coal mines.[4] Table 6 gives the various other data for the same year.

E. Forests in Industrial Economies. The continuous spread of industrial areas makes it desirable to study the role, actual and poten-

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[1] J. K. Haywood, *Injury to Vegetation and Animal Life by Smelter Fumes,* Bulletin 113, revised, Bureau of Chemistry, United States Department of Agriculture, Washington, D. C., 1910.

Stuart Chase, *Rich Land, Poor Land,* p. 59, Whittlesey House, McGraw-Hill Book Company, New York, 1936.

[2] W. D. Brush, *Timber Requirements for Mines in the United States,* p. 16, United States Forest Service, Washington, D. C., 1938.

[3] Chapter I, Section 1.

[4] Brush, *op. cit.*

tial, of forests in such areas. Industrialization universally increases population and promotes urbanization, thus augmenting the demand for local food supplies and raw materials. This, in turn, results in overcut forests and wasted soils. The tapping of distant supplies is then necessary. Proving more satisfactory and abundant, they depreciate the value of the remaining local supplies, causing the rural population to move away and leave behind abandoned farms and wrecked forests.

TABLE 6

MINE TIMBERS USED IN THE UNITED STATES IN 1935[1]

Kind of Mine	Mine Production (Millions of Short Tons)	Timber Used (Millions of Cubic Feet)	Cost Per Ton Mined	Total Cost (Millions)	Cost Per Cubic Foot
Coal					
Bituminous	369.324	141.042	$0.382	$17.693	$0.125
Anthracite	51.003	37.728	0.740	4.433	0.117
Iron	34.205	5.417	0.158	.710	0.131
Other metals	52.300	31.541	0.603	4.692	0.149
Total	506.832	215.728	0.426	27.528	0.128

[1] W. D. Brush, *Timber Requirements for Mines in the United States*, p. 15, United States Forest Service, Washington, D. C., 1938.

This process has gone on in the vicinity of the great eastern cities for over a century. The surrounding forests, aided by time and, more recently, by fire protection, are recovering and spreading over the abandoned farmlands. Using the region of metropolitan New York as a case in point, new and second-growth forests now cover nearly half of the countryside within a radius of 100 miles. Yet this region is one of the richest and most densely populated in America. There is no complete study of how the forests of this or similar regions do function or, properly handled, might function in their economy, but partial studies give a generalized picture.[1]

[1] References to a portion of this region are

A. F. Hawes, *The Present Condition of Connecticut Forests*, Connecticut State Forestry Department, Hartford, 1933.

P. L. Buttrick, *Public and Semi-Public Lands of Connecticut*, Connecticut State Geological and Natural History Survey, Hartford, 1930.

P. E. Bruns and R. C. Perkins, *The Industrial Uses of Wood in New Haven and Fairfield Counties*, Connecticut State Development Commission, Hartford, 1940.

The whole region is predominantly industrial. It is dotted with cities and towns averaging about 10 miles apart, some of which are themselves industrial centers of consequence. All have manufacturing industries of some sort. Agriculture, except for dairying, market gardening and other specialized branches, is almost a thing of the past. It occupies only especially selected lands. Some counties have scarcely a single farmer left. The rest of the area is forested, but it makes small contribution to the regional industry or in supplying wood products. A few small sawmills operate chiefly as farm enterprises, some small products plants use local wood, and a good deal of firewood is cut, largely for the fireplace trade, but the bulk of the lumber and other forest products comes from distant sources. Even the majority of the wood-using industries import their supplies.

It would not be true to say that the population does not value this forest. Much of it is held at prices exceeding its timber value. The public taxes itself for fire and other protective activities, tends to favor programs for public forest and park acquisition, and considerable private forest planting is carried on. This popular interest is not in commercial terms; it boils down to thinking of the forest as a setting for agreeable living. It is logical, therefore, to call most of it *luxury forest*.

Immediately surrounding the cities, the forest is dotted with suburban homes; situated at greater distance, these homes become private estates, primarily for summer use. Farther afield, farm ownership still accounts for considerable acreage, but most of it is for sale and is gradually passing into the hands of estate owners and, to a lesser extent, of public agencies.

Public ownership is divided among public or semi-public watershed protection lands; state forests; state, county, or municipal parks; and state forests. The area involved probably does not exceed 10 percent of the forest area. The chief use of the forest, public or private, is recreational; even the state forests are thought of publicly in terms of recreational use. Next comes public water supply (Sec. 6*A*); lastly, timber production. There is need for enlarged public holding for all these purposes. Although slowly increasing, they are not likely soon, if ever, to make heavy inroads on private ownership.

The small contribution which the forests make to regional industry is due to their generally immature character and the general attitude of recreational owners who do not need to make money from their forests and are frequently opposed to cutting in any form. Consequently, a large volume of timber is gradually accumulating in the region, although less rapidly than if cultural measures were employed,

and users of forest products are paying an increased toll for products brought from distant sources.

Treated on the basis of continuous timber production, these forests could make a far greater contribution to regional life than is now realized without in the least depreciating their recreational and other values (Chapt. XVI, Secs. 2 and 3). Many difficulties face both the owners and the public in instituting such constructive treatment (Chapt. XVII, Sec. 5*B;* Chapt. XIX; Chapt. XXI). These difficulties should be capable of solution. If they remain unsolved, we may look forward to continuation of present policies as long as private owners can afford to treat their forests as luxuries; if and when they can no longer do so, a "cut-and-slash" period will ensue.

7. FORESTS IN A PLANNED ECONOMY

The imperfections of our economic system (Chapt. VIII, Sec. 5) result in unemployment coupled with overproduction, loss of soil productivity from overcropping, fished-out streams, deforestation followed by floods and soil erosion. Many believe society must organize under a master economic plan to iron out these maladjustments. Consequently, we hear much of national economic planning and land-use planning.[1] The proponents of large-scale economic planning would organize producing and consuming capacity so that industry and agriculture would always function on a level high enough to provide adequately for everyone, thus securing an economy of abundance (Chapt. VIII, Sec. 5). They assume that the wherewithal would come from the full employment necessary to secure full production. Land-use planners desire that all land be put to its most socially valuable use, thus preventing waste of natural resources. Its widespread and successful application might not realize all the objectives of a planned economy but would be a long step in the right direction.

Let us see how forests would function under such systems, first considering land-use planning or, as it is frequently called, *land zoning.* At present landowners are largely free to do as they please with their lands (Chapt. XIII, Sec. 3). The owner of a valuable mountain forest may destroy it to make a corn field which soon will wash away and cause damage to lands lower down the slope. A lot owner in a high-class residential district may depreciate, in the absence of specific legal restriction, the value of his neighbor's property by putting up

[1] G. A. Soule, *Planned Society,* The Macmillan Company, New York, 1932, and Stuart Chase, *Rich Land, Poor Land, op. cit.,* are good popular references to these movements. Chase also paints a graphic, if slightly uncritical, picture of the waste of all natural resources in America.

a filling station. To prevent such happenings, cities often enact zoning laws, specifying how urban property may or may not be used. Certain states are experimenting with zoning to prevent farming on non-agricultural lands [1] (Chapt. XXI, Sec. 4).

The land-use planners would zone the whole country, alloting to each area its proper use, and would make such use mandatory. They also would include water use, which is logical since the two are so closely interrelated. Foresters would wish to divide the area, zoned for forests, into subzones for different forest uses. Public forests are zoned in this way as an essential of good forest management, but such forests cover only a minor fraction of the total forest area. The government-sponsored economy, being built up in the Tennessee Valley by the TVA, is a large-scale example of land planning.[2] When the Soil Conservation Service helps a farmer plan his operations to preserve his soil, it is furnishing a small-scale example of the same thing.[3]

Figure 17 represents an imaginary region covering millions of acres that are zoned for major and minor land and forest uses. It extends from sealevel to the summit of a 10,000-foot mountain range. A range of flat-topped hills screens the area immediately to its north from abundant rainfall so that it is semi-arid. The coastal zone is well watered. On one side of the river it is flat and marshy, interspersed with sandy plains; on the other it is somewhat precipitous. Larger population centers are at the mouth of the river and at the junction of its larger tributaries.

The major zones, starting from the mountain summit, are

(1) Protection Forest Zone (Chapt. XVI, Sec. 1). All cutting is prohibited on steepest slopes, selection cutting rigidly controlled on occasional less steep areas. Summer grazing in mountain meadows and elsewhere where it is safe links this area with Zone 4 (Sec. 6*C*).

(2) Timber Forest Zone. This zone is devoted to the production of forest crops, reproduction being obtained by whatever silvicultural system is suited to the stand involved. No land may be permanently cleared.

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[1] W. A. Rowland and F. B. Trench, *Rural Zoning Ordinances in Wisconsin*, Circular 281, Extension Service, University of Wisconsin, Madison, 1936.

[2] *TVA, Its Work and Accomplishments*, Government Printing Office, Washington, D. C., 1940.

[3] The National Resources Committee, Washington, D. C., has published a number of regional and state planning reports which should be consulted by those concerned with land planning in greater detail. The December, 1934, report of the National Resources Board is a detailed study of the basis of land-use planning for the United States as a whole.

(3) Irrigation Agricultural Zone. This zone is based on water collected from Zones 1 and 2.

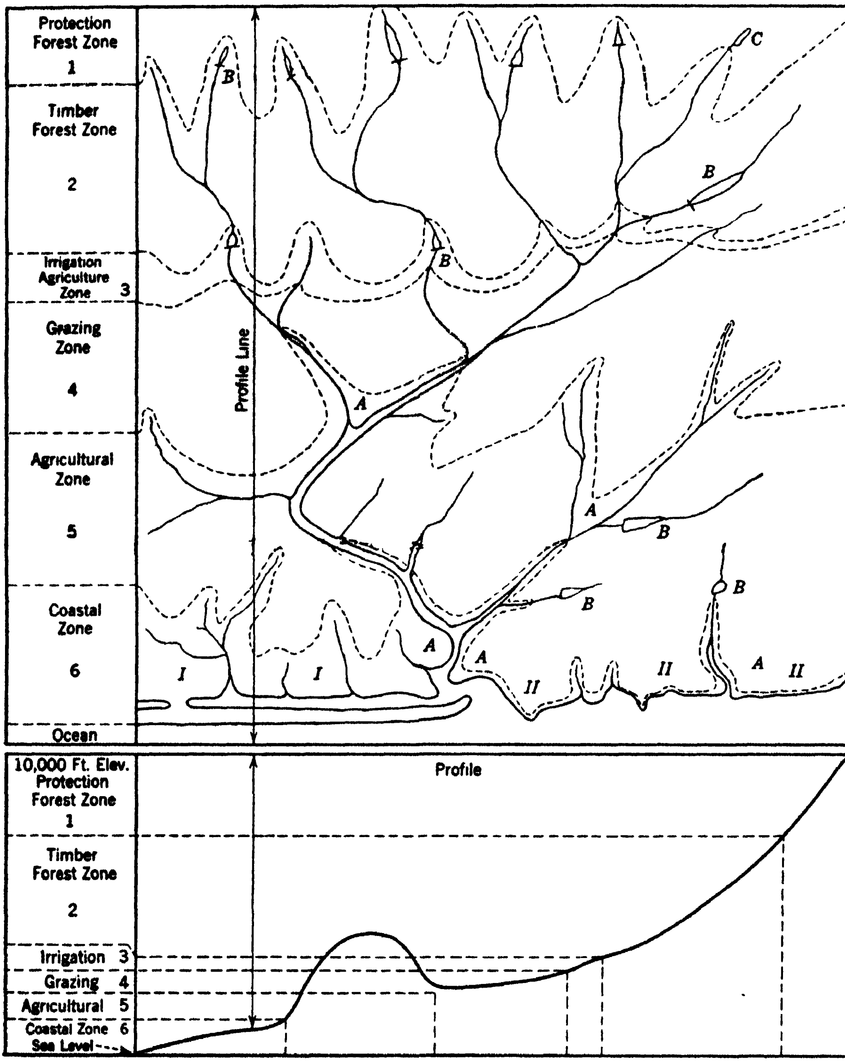

Fig. 17. Area zoned for major and minor land uses. Major uses on basis of soil, topography, and rainfall. Minor uses are in relation to needs of local communities.

(4) Grazing Zone. Lack of rainfall here makes either ordinary agriculture or forestry impossible or dangerous. Dry farming is prohibited because of the danger of wind erosion.

(5) Agricultural Zone. In this zone forests are confined to woodlots that are restricted to poor soils and occasional steep slopes on which forest clearing or growing of crops is prohibited.

(6-I) Flat Coastal Zone. Land here is largely non-agricultural and consists of large open swamp areas zoned for wildlife. Forests in the immediate vicinity of the coast are zoned for protection against coastal erosion and dune formation. Farther inland they are set aside for timber producing with year-long grazing as a secondary use. Recreational use is provided for where necessary—chiefly in the form of hunting, fishing, and small boating.

(6-II) Narrow Coastal Zone. Forests are unimportant except as an adjunct to the seacoast resorts of the shore-hotel and summer-cottage type.

Within these major zones certain smaller areas are zoned for special forest or non-forest purposes. Urban and suburban zones (*A*) include and surround all cities and towns and provide for public parks, forested or otherwise, for residential, commercial, and industrial uses. Regions around lakes and artificial reservoirs (*B*) are zoned according to the use of the water, those zones near cities and towns being closed to forest recreation since their water is used for domestic purposes. Water bodies in Zones 1, 2, and 3, being for regulation of stream flow, power production, and irrigation, rather than for potable supplies, are open to recreation. In all zones, forests immediately along the banks of streams must be kept intact to prevent bank washing except where engineering works, such as docks, render it unnecessary. All public forests are open to recreation except where water protection otherwise requires. Certain scenic areas are zoned exclusively for recreation (*C*).

Such a system of land zoning presumably would be effective in preventing land from being put to uses to which it is not physically, economically or socially suited and probably would result in adequate water control, but it would not necessarily result in full productivity. Although complete deforestation in certain zones would be forbidden, there is a vast difference between cutting in such a way that the forest can renew itself in time and handling it on a sustained-yield basis (Chapt. XV). Presumably, under a fully planned economy, all forests except those reserved for special purposes would be put on a sustained-yield basis and an attempt would be made to keep the annual production at a level high enough to yield all the forest products that could be used under an economy of abundance (Chapt. VIII, Sec. 5). Whereas such an economy, if it could be organized on a workable basis, would be to the long-run advantage of forest owners, it would restrict their ability to make a large profit all at one time by heavy liquida-

tion cutting or it might have other disadvantages from their point of view (Chapts. XV and XXI).

8. FORESTS IN A WAR ECONOMY

Modern total war requires a special economy whose only objective is to facilitate the destruction of the enemy's armed forces and the breakdown of his civilian morale. This requires the investment of huge amounts of capital, labor, and raw materials for the production and use of machinery to destroy or prevent the enemy's receiving supplies of similar machinery. We see the process in its naked simplicity when an airplane drops a bomb on a factory and the next instant is shot down by a defense plane which, having been injured in the combat, falls in flames. The net loss in capital is several hundred thousand dollars in a few seconds, not including the peace-time producing value of the factory, two pilots, several machine gunners, and an unknown number of factory workers. The indirect effects of economic war are seen in the workings of blockades, intended to prevent the enemy from receiving food and war supplies. This disrupts international trade between nations not themselves at war and causes great human suffering.

The enormous demands for capital, material, and labor in a war economy mean their withdrawal from constructive peacetime enterprises, both private and public. Public services not immediately necessary to the military machine suffer from lack of funds. Capital flows into war industries; prices, taxes and living costs rise although governments frequently attempt to freeze the price structure to prevent popular unrest.[1] Huge borrowings increase the interest rate,[2] for modern war, in democratic countries at least, cannot be financed entirely out of taxes. A war economy, therefore, takes on a boom character. A few years after peace has been declared, the boom bursts, leaving victor and vanquished alike with their capital resources depleted, their producing plant in war industries vastly expanded and without a market, and with a huge debt upon which interest must be paid out of depleted natural and human resources. Britain has not yet paid all her Napoleonic War debt; the United States is still paying Civil War bills, and a large share of the first World War debts were repudiated by victor and vanquished alike. Economists consider the depressions

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[1] C. O. Hardy, *Wartime Control of Prices*, Brookings Institution, Washington, D. C., 1940, takes up results of price control in the first World War. It is too soon to consider similar controls in the second World War dispassionately.

[2] Unless controlled by governmental action.

in 1873 and 1929 to have been, in part at least, aftermaths of the Civil and the first World Wars.

During the war itself, forests in the fighting zone suffer direct damage from shellfire and deliberate burning. When occupied by the enemy, they are usually overexploited for the needs of his military machine. Over 1.4 million acres[1] of French forests were destroyed in the battle zone of the first World War, about one-third of the forests completely ruined so that replanting was required. The loss over a period of 40 to 50 years was estimated at $280 million[1] (1918 rate of exchange). Such losses, both present and future, must be borne by the owners and nations involved; cash compensation, even if forthcoming from the vanquished for forest losses in temporarily occupied territory, does not restore the forests themselves. Both France and Belgium exacted reparations for forests destroyed by the Germans in the first World War; France by deliveries of forest products; Belgium by annexation of a forested part of Germany.

Forests make a strong defensive barrier to invasion and an excellent protection to troops. In the American Revolution, Arnold's expedition against Quebec was in no position to push home its attack after its long struggle through the Maine woods. The forests on the battlefield of the Wilderness were a help to Lee and a hindrance to Grant. In the second World War, the Finnish forests enabled the Finns to stand off the initial attack of the mechanized army of the Russians with non-mechanized troops. In the Riff War the Spaniards could not conquer northern Morocco until they had burned over its dense cork-oak forests in which the Arabs constantly ambushed the Spanish columns. Spaniards and Arabs alike thus lost one of Morocco's most valuable resources. Hand-to-hand fighting in forests is very sanguinary, but use of artillery at close range or of mechanized columns is impossible. Forests also serve as concealment against aerial reconnaissance and attack. All this gives them a lifesaving function.

Forests in zones remote from the front must furnish vast quantities of material for military uses, varying from selected walnut gun stocks to green lumber for shoring trenches, building cantonments, and repairing destruction from bombardments. So pressing were the needs of the military machine in the last war that all the major armies organized forestry troops, really militarized lumberjacks and sawmill hands. It goes without saying that cuttings made in war times, even those under forestry principles, are seldom up to peace-time standards

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[1] "Notre Domaine Forestier et la Guerre," *Bulletin de la section d'information du G.Q.G.*, Nouvelle Série 102, 1919.

and the necessity to overcut must be recognized. Germany is currently reported to be overcutting in her own forests and to have required it in occupied Czechoslovakia even before the present war began in order to build up her war economy. A nation may build up such an economy in preparation for war as well as after it has started.

Forests affect war on sea as well as on land and, in the days of wooden ships, sea power depended upon forests. In the long seventeenth and eighteenth century struggle between France and England, England, although she lacked forests, could import timber more easily than France, whose ship losses could not be replaced readily. This, rather than a small battle under the walls of Quebec, decided the fate of Canada.[1] Today we are unpleasantly familiar with blockades preventing the importation of forest products.

9. DISTRIBUTION OF INCOME FROM FORESTS

Every operation in growing, transporting, manufacturing, and using forest products starts a flow of income, the ultimate recipients of which are far removed in time and space. No amount of search will discover the last one, for each must pass on a portion of his benefits, but the search is fascinating and helps to make clear the economic role of forests.

A. Distribution of Income from Logging and Lumber Manufacture. Figure 18 shows the widening distribution of gross income from sales of rough lumber by a lumber manufacturing company that buys stumpage as it operates and sets up no reserves. Circle I represents this gross income, Circle II its primary distribution. The percentages are probably not far from national averages, if they could be determined. Had the company purchased stumpage in advance, its percentage would be smaller, but taxes and interest on borrowed capital would be higher (Chapt. X, Sec. 4). Circle III shows the uses of payment by the recipients. Since the bulk of the payments are for wages and salaries and a part of the dividend payments also go directly to individuals, they are spent almost immediately, somewhat as shown in Circle IV. Most of the remaining payments also eventually reach individuals. Each payment may therefore start another infinite series of widening income-distribution circles.

The volume of this income depends on the size of the operation involved. A small portable mill may keep a dozen farmhands busy all

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[1] See R. G. Albion, *Forests and Sea Power—The Timber Problem of the Royal Navy 1652–1862,* Harvard University Press, Cambridge, 1926, for discussion of the effects of forests on the long series of wars between England and France.

winter (Chapt. X, Sec. 5). Assuming 20 man-hours as the average labor time to log, transport, and saw 1 M. bd. ft. of rough lumber,[1] an operation of 10 M. bd. ft. per year would require some 70 men. This, including supervisory personnel and those persons supplying the

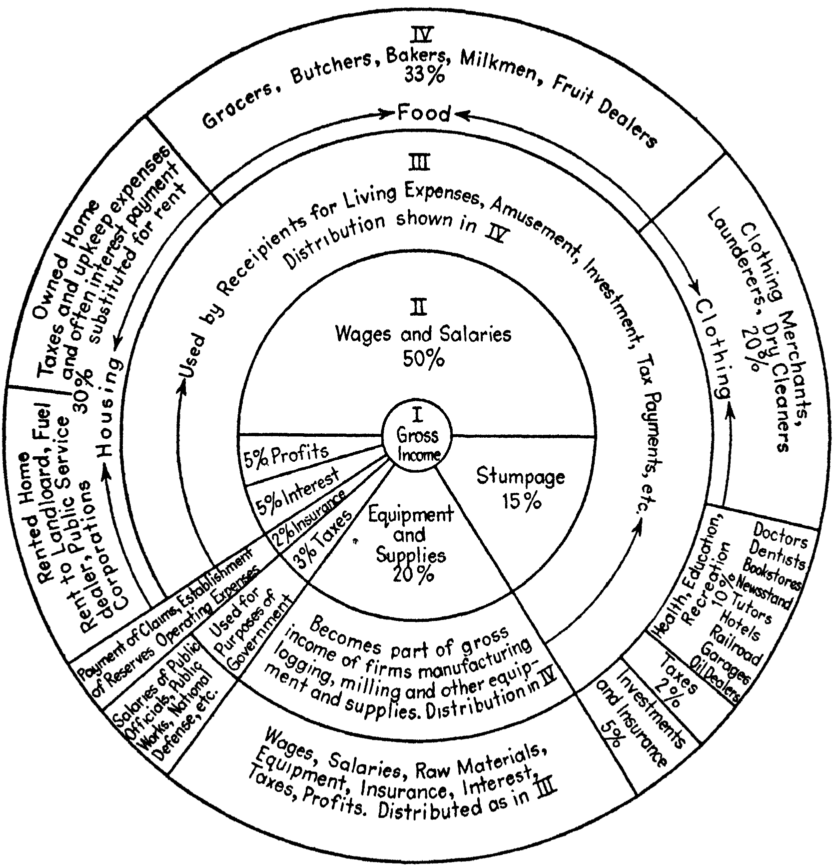

FIG. 18. Distribution of gross income from operations of a lumber-manufacturing company.

needs of workers, would mean 100 people or, including their families, a community of 250 to 300 persons. A group of such mills, accompanied by finishing and by-products plants, would mean a small city.

Table 7 gives an idea of what primary manufacture of lumber means

[1] B. H. Topkis, *Labor Requirements in Lumber Production,* Serial R 529, Bureau of Labor Statistics, Department of Labor, Washington, D. C. Reprinted from *Monthly Labor Review,* May, 1937.

in employment, dividends, and other payments for the whole United States. The year chosen was not a particularly good one for the industry.

TABLE 7

EMPLOYMENT, WAGES, VALUE OF PRODUCTS, ETC., IN THE LUMBER AND TIMBER PRODUCTS INDUSTRY, 1935

Number of establishments[1]	5,980[2]
Average monthly employment[1]	255,230[2]
Wages[1]	$ 182,988,586[2]
Stumpage, materials, supplies, etc.[1]	208,047,016[2]
Cash dividends[4]	35,980,000[3]
Total taxes paid[4]	26,271,000[3]
Gross sales[4]	1,252,157,000[3]
Value of land, stumpage, equipment, etc.	1,101,447,000[3]

1 Not including salaried employees, nor mills producing less than 50 M. bd. ft. per year.
2 Bureau of Census, Industry Series 31, Mar. 27, 1937.
3 *Statistics of Income*, Bureau of Internal Revenue.
4 Covers a slightly larger number of establishments than Footnote 1 but only those having an income large enough to come under the income tax law. All figures include a small amount of secondary lumber and other forest products manufacture.

It is evident that the gross sales of slightly over $1.25 billion for 1935 must have made a considerable contribution to the national income of that year which was slightly under $56 billion, even though gross sales do not all go into income (Chapt. XII, Sec. 4).

In 1935 the forest industries of all kinds, primary and secondary, numbered 19,072 establishments and gave an average monthly employment to 832 677 persons, who earned a total of $774,120 thousand. This was about 10 percent of the labor in all manufacturing industries.[1] The total value of forest products produced was over $3185 million.

B. Distribution of Income from Transportation, Remanufacture, and Use of Lumber. Figure 19 illustrates the major uses of lumber and charts its course from mill to ultimate consumers and shows the nature of the returns from each operation, as direct profits or in forms of satisfaction. It also shows the returns to labor and to furnishers of equipment and supplies. The boxed letter (*A*) indicates the profit to ownership and (*B*) the disbursements for labor, materials, and supplies. Together they constitute that portion of the gross income of the manufacturer, transportation agent (*T.A.*), or dealer, derived from handling the lumber. This sum participates in the formation of widening in-

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1 See *1939 Statistical Abstract* of the United States Bureau of Census, Washington, D. C., 1940, which, in Table 814, pp. 775, 786–788, gives a full breakdown by classes of establishments.

come circles similar to those shown in Fig. 18. In the lower portion of Fig. 19 the nature of profits from ultimate consumption is indicated. No attempt is made to show all possible ramifications of physical distribution as, for instance, that part of an export order might be filled from a retail yard or that all the lumber used on a large building job might be shipped direct from a mill having a finishing plant.

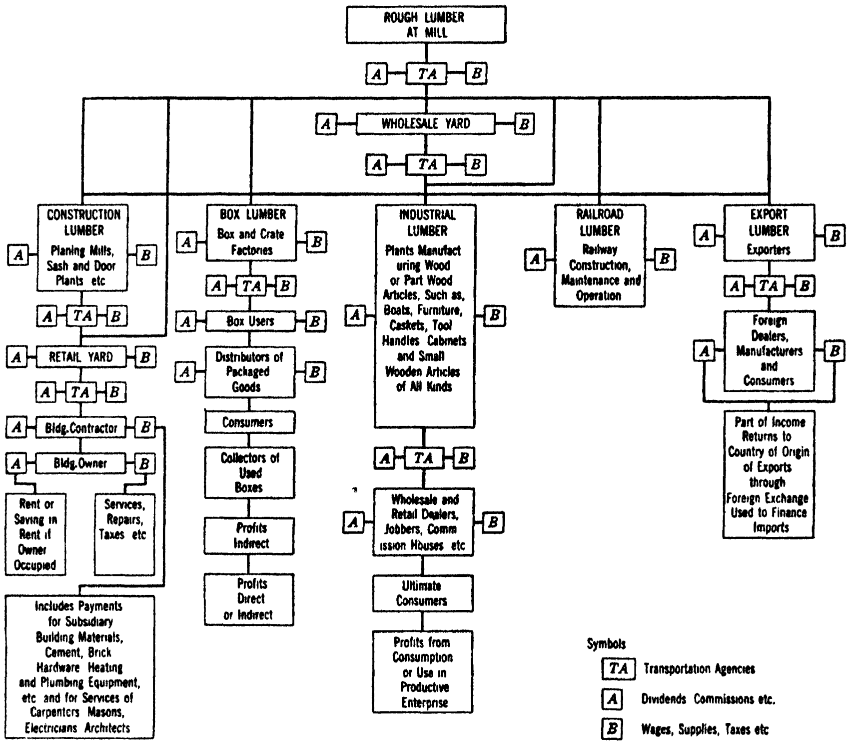

FIG. 19. Major uses of lumber and the distribution of the income from its production, transportation, and consumption in the United States.

It would be utterly impossible to estimate the value to consumers of all the lumber produced in a given year, but the following figures help to visualize the income derived from its distribution. In 1935 there were 1597 wholesale lumber establishments, active ownership of which was shared by 701 persons who had 15,170 employees and paid them \$24,356 thousand, plus 21,149 retail lumber yards actively owned by 10,819 persons, having 90,858 employees and paying them \$108,801 thousand.[1] It is estimated that, in 1935, 58,405,647 man-hours of direct

[1] *1939 Statistical Abstract* of the United States Bureau of Census, Washington, D. C., pp. 842 and 848.

and indirect railroad labor was utilized in transporting lumber, lath, and shingles on Class 1 railways of the United States, not including loading or unloading the cars.[1] This amounted to 3.764 man-hours per ton and 1.15 to 2.3 tons equals a thousand feet board measure of lumber.[2]

Charts could be constructed for other forest products industries, differing in detail but also showing the ramifications of economic and other benefits from the conversion of standing trees to finished products.

C. Distribution of Returns from Protection, Recreation, and Wildlife Forests. In addition to the costs of protection, the effective use of such forests requires a considerable capital investment for dams, power lines, roads, and recreational or wildlife improvements of various kinds. Capital expenditures for dams and for pipe and transmission lines frequently run into hundreds of millions. Intensively developed recreational facilities easily may amount to hundreds of thousands. Wildlife developments are considerably less expensive.

The returns to those who protect the forests and to those who lend the money or build and operate the facilities for their use for any of these purposes are direct; those for the users of the facilities may be direct, indirect, or intangible (Chapt. VIII, Sec. 1). The private owner of a forest recreation camp receives a direct return from rentals, as does the bank holding the mortgage on it. The local merchants get an indirect return from sales to owners and campers. The local farmers have a market for fresh produce close at hand instead of in a distant city. The camp users get an intangible benefit. If the camp is publicly owned, the rentals go into the public treasury and, if the enterprise is a public one and yields a financial profit, it reaches the public in the form of tax reductions.

Figure 20 shows the distribution of returns from these three types of forest. It assumes private ownership and operation and makes no attempt to show either the returns to the public in the form of taxes or the returns to ownership from the sale or use of forest products removed incidental to construction, operation, or improvement of the forest for its intended purpose. Nor does it take into consideration the possible gains from the enhanced value of property to both the sur-

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[1] J. A. Ball, *Labor Requirements in Rail Transportation of Construction Materials*, Serial R 637, Bureau of Labor Statistics, Washington, D. C. Reprinted from *Monthly Labor Review*, October, 1937.

[2] R. C. Bryant, *Lumber, Its Manufacture and Distribution*, 2d edition, p. 507, John Wiley and Sons, New York, 1938.

rounding property holders and the public or, for that matter, the possibility of their depreciation in values (Chapt. XVI, Sec. 2). A diagram, constructed for public areas, would differ only in minor details.

D. Distribution of Returns from Forestry. It now remains to consider the income distribution from forestry itself. In so doing one

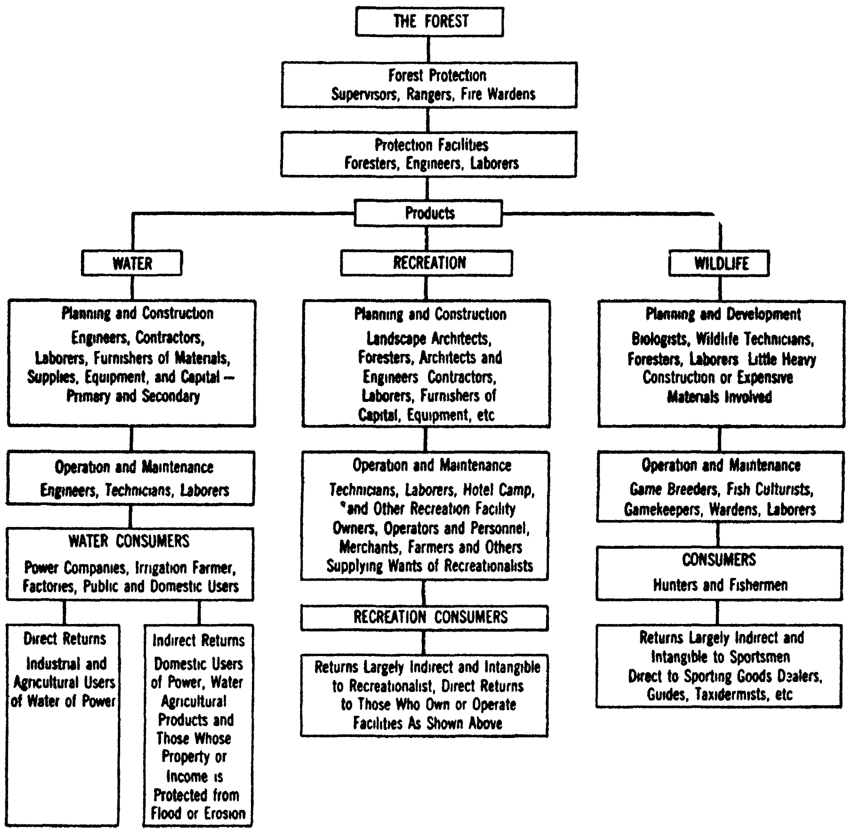

FIG. 20. Distribution of returns from watershed, recreation, and wildlife forests, under private ownership. Returns to owners from possible sales of forest products not shown. Returns to public from taxes are not shown. (See p. 171.)

discovers that the oft-repeated statement that there is no profit in forestry till the crop is harvested applies only to the owner—all the money he has expended meanwhile has become income to others.

Figure 21 shows the nature and distribution of expenditures necessary to establish a forest on bare land and carry it to maturity. They are discussed in Chapters XIII and XIV. The project is assumed a private one and the capital is assumed borrowed and nursery stock

Development Steps	*Expenditures for*	*Duration of Expenditure*	*Primary Recipients*
1. Site investigation	Salaries and field expenses; office and field equipment	One to several years	Foresters, engineers, clerks, dealers in office and survey equipment
2. Purchase negotiations	Salaries and travel of negotiators	One to several years	Lawyers and real estate agents
3. Land purchases	Land payments, transfer fees, etc.	One to several years	Landowners, mortgage holders; towns or counties and/or their officials
4. Land carrying charges	Taxes; interest on borrowed money	Taxes, annual; interest until loan is repaid, ordinarily when crop matures	Town, counties, or states; lending agencies
5. Growing planting stock	Use of land; taxes; hire of labor; cost of seed, fertilizer, and equipment	Until entire area is planted	Taxes and interest as in 4; foresters, seedsmen, nursery technicians, laborers; dealers in fertilizers and nursery equipment
6. Field planting	Supervision and labor; transportation, tools, etc.	One to several weeks annually until area is planted, often not until end of first rotation	Labor and transportation agencies moving the trees from nursery to planting site
7. Protection	Fire, disease, and trespass control	Annual	Rangers, fire guards, dealers in fire-fighting and transportation equipment
8. Engineering improvements	Supervision, labor, materials, equipment and supplies for construction and maintenance of fire towers, roads, trails, firebreaks, ranger stations, etc., plus interest on borrowed money	Construction cost till all are completed and paid for; maintenance cost annual	Foresters, engineers, carpenters, telephone linemen, other technicians and laborers; dealers in construction equipment and supplies; capital lending agencies
9. Silvicultural operations	Salaries and wages; transportation and equipment	Annually or periodically from time first cultural operations are started, usually about tenth year after planting	Foresters and laborers, etc.

FIG. 21. Income recipients from the development of a forest on bare land up to the time of its maturity. (See p. 172.)

purchased. Under different conditions, certain expenditures might disappear and others be differently distributed, but the essentials would be unchanged. The largest expenditure is for labor; indeed, only in the construction of engineering improvements (Chapt. XIV, Sec. 4) is much expensive equipment or many materials required.

Using approximate figures, how much labor would it take to establish a 10,000-acre forest and develop it to maturity? The assumptions made are (1) that all land is bought before planting is started; (2) that it will require 50 years for plantations to mature; (3) that 200 acres are planted each year so that at the end of the period the forest will be on sustained yield; (4) that engineering improvements are spread over the whole period, being constructed as needed; (5) that silvicultural improvements start the tenth year and continue annually thereafter.

The investigation and stages of land purchase require comparatively little labor, but they bring money into the community, particularly from land-purchase payments which enable old debts to be paid and barns to be repaired, and give the community a start in getting on its feet. (Section 12 indicates the desperate poverty of many regions where such projects are set up.) The estimated labor requirements for the 50-year period, expressed in man-years (Chapt. VIII, Sec. 2*D*), are as follows.

Growing planting stock	50
Forest planting	85
Administration and protection	125
Engineering improvements, construction [1]	200
Engineering improvements, maintenance [1]	100
Silvicultural improvements [1]	40
Total	600

This amounts to an average of 15 men directly employed on a year-long basis, for the 50-year period, or one man to every 666+ acres. Actually the employment would be in part seasonal, but the amount of full-time employment would increase with the years and some of it would be at least semi-technical and therefore relatively high paid. Employment of 15 men may seem a small matter except to those concerned, but 10,000 acres are a drop in a bucket of millions of acres of forest land in the United States, so badly devastated as to require planting (Sec. 10). The matter of labor requirements in forestry and the forest industries is so important that it is discussed further in the next section.

[1] See Chapter XIV, Sections 4, 5 and 6.

10. LABOR REQUIREMENTS IN FORESTRY

The large labor requirements in forestry and its dependent industries have great economic and social significance in modern societies which, owing in part to substitution of machine for manual labor in both industry and agriculture, often results in huge unemployment problems.

No doubt science will find further means to substitute mechanical for human energy in the forests as it has elsewhere, but its limitations (Chapt. VIII, Sec. 2*E*) indicate that the hand planting tool and the axe are not likely to become memories. Table 8, listing the percentages of decrease in recent years in the number of man-hours necessary to produce a unit of product of various commodities, indicates that mechanization in the forest products industries has tended to lag behind other industries.

TABLE 8

DECREASE IN MAN-HOURS NECESSARY TO PRODUCE A UNIT OF PRODUCT IN VARIOUS INDUSTRIES [1]

Year			*Year*		
1919–1935	Steel	57.5	1919–1935	Lumber and timber products	23.0
Do.	Cement	52.7	Do.	Planing mill products	24.5
Do.	Sugar refining	69.4	Do.	Furniture	28.2
Do.	Meat packing	31.5	1923–1935	Rubber tires and inner tubes	96.3
Do.	Flour	40.0	1927–1935	Wood pulp	37.9
Do.	Cotton goods	37.1			

[1] "Employment and Production in Manufacturing Industries, 1919 to 1936," *Monthly Labor Review,* Serial R 1057, December, 1939, Bureau of Labor Statistics, Washington, D. C. For a general and detailed discussion of the problem of mechanization as related to the forest industries see *Mechanization in the Lumber Industry,* Work Projects Administration, Report M 5, Philadelphia, Pennsylvania, 1930.

The opportunities of mechanization are even more restricted in the operations of establishing and building up forests than in mining or harvesting them, although it is probable that mechanical means of performing operations such as planting and brush disposal will lower somewhat the man-hours necessary for these and similar operations. Nevertheless, the opportunities for the use of labor in building up our depleted forests are enormous and can be used to great social service.

There are some 130 million acres of cutover forest and abandoned agricultural land available for starting forests, literally, from the ground up, since they are now practically destitute of potentially

valuable tree growth.[1] Despite the work, mostly on public forests, of more than 300,000 CCC men for nearly 10 years, the surface has scarcely been scratched. Allowing a man-per-acre ratio of 1 to 600 (Sec. 9*D*), 200,000 men could be kept busy for nearly two generations on these ought-to-be-forested lands without any reference to the much larger acreage now bearing forest which needs protection and improvements.

A ratio of 1 to 600 is very low for intensive forestry (Chapt. XIV, Sec. 2) that is coupled with the manufacture of products and multiple use of forests. Under such conditions it is not too much to say that it might easily be one man to 50 acres as it is in certain places in Europe. Under large-scale liquidation operations it would be far greater—while it lasted. On protection forest not used for other purposes, direct employment being restricted to guards, it might be as low as 1 man to 10,000 acres. If one uses a 1-to-1000 ratio as an average for forest work other than harvesting and manufacture, we find possibilities for employment for over 600,000 men on the present forest area of the country,[2] not including the manufacture of forest products, or for indirect employment.

TABLE 9

ESTIMATED MAN-YEARS OF EMPLOYMENT IN FORESTRY AND THE FOREST INDUSTRIES IN 1936 [1]

Kind	Direct Employment	Indirect Employment	Total
Forest products	1,392,500	1,937,500	3,330,000
Forest grazing	196,000	27,000	223,000
Forest wildlife	23,000		23,000
Forest watersheds	13,500		13,500
Forest recreation	125,000	70,000	195,000
Total	1,750,000	2,034,500	3,784,000

[1] United States Forest Service, *A National Forest Economy*, p. 90, 1939.

Table 9 gives a United States Forest Service estimate of the direct and indirect employment furnished by American forests in 1936. This, of course, includes work both in forests and factory. It totals 3,784,-

[1] Copeland Report, pp. 18 and 50.

It must not be forgotten that the labor cost increases with the decreased size of timber handled (Chapt. X, Sec. 2), and under systems of forest production shorter rotation generally means smaller-sized timber than is obtained from virgin forests.

[2] *A National Forest Economy*, op. cit., p. 90.

500 man-years, a ratio of 1 man to 168 acres of the total forest area, or 1 man to 124 acres of commercial forest. By expenditure of sufficient capital, the Forest Service estimates that this employment could probably be doubled.

It would seem from a consideration of the items other than forest products in Table 9 that the 600,000 man-year estimate for work in forests themselves, made in the previous paragraph, is a modest one. Employment in forestry and in the forest industries is not simply a matter of a few foresters and a lot of lumberjacks and sawmill hands. Public forestry agencies and the various primary forest industries draw, for their staffs,[1] from no less than twenty professions and on men of special scientific training of professional status. They also use men from as many technical and skilled trades not necessarily of professional grade,[2] without reference to many special skills peculiar to lumber and forest products industries, such as sawfilers, skidder operators, dry-kiln and turpentine-still specialists.

11. FOREST OWNERSHIP

Perhaps the chief factor affecting the kind, volume, and time distribution of the economic and social returns from forests is the nature of their ownership. A nonresident owner, operating on a liquidation basis with an anti-labor policy, not only leaves less income in the community than does a resident who has a more enlightened labor policy but also, after liquidation is complete, he leaves nothing. Huge privately owned luxury forests of valuable timber from which no products are cut and to which the public is denied access afford few community benefits. Even when their owners do not take advantage of their strategic position to keep down taxes and to discourage economic activities, they add little to the welfare of the communities or the public at large. The best that can be said is that they constitute reserves of timber and recreational space for the future.[3]

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[1] Among them are: foresters; botanists; zoologists; entomologists; pathologists; wood technicians; landscape architects; physicists; meteorologists; civil, mechanical, electric, hydraulic, sanitary, and logging engineers; chemists, including specialists in soils, cellulose, and resins, and in other wood-derivative products; economists; lawyers; certified accountants; physicians; nurses.

[2] Among them are: forest rangers; surveyors; stationary, locomotive, telephone, radio, automotive, and marine specialists; mechanics; carpenters; blacksmiths; statisticians; bookkeepers; social workers; recreation leaders; chefs; grazing specialists, and laboratory technicians of many different kinds.

[3] Such ownership is not widespread in America, but under different economic conditions might become so. However in certain localities it is important.

What type of ownership is most favorable to a widespread distribution of forest benefits on a continuing basis? (1) It must be sufficiently intelligent to grasp the concept of continuous production of forest crops, and to some extent the nature of indirect forest values, and to have at least a slight knowledge of forestry technique. (2) It must be strong enough financially or must have sufficient borrowing power to be able to wait for returns and a temperamental willingness to do so (Chapts. V and VI). (3) Owners who realize the benefits to themselves of improving the community in which they operate are the more likely, as the saying goes, to be "forest-minded." Socially profitable use of forests also requires a reasonable continuity of ownership. It is just as idle to expect good forestry in forests that change hands every six months as it would be to expect good farming under such conditions.

Individual forest holdings range in size from fractional acres to millions of acres or more, and they may be solid or scattered among other forest and non-forest holdings. The size and concentration of holdings makes a difference to the community. The misuse of small areas, except where they are the key to much larger ones, may have but minor social significance. When a forest operation strips a million acres, it knocks the props from under the economic structure of an area 40 miles square. The same amount of destruction scattered over a dozen states is less significant.

Large consolidated forest holdings do not necessarily function to the best social advantage. A corporation, owning several million acres in a solid or near solid block, usually controls the social and political as well as the economic life of the region—a control which, even though its forestry practices may meet the highest standards, may have disadvantages under any form of government. The same thing can also be said of public ownership in countries not democratically controlled.

In regions where ownership is of widely varying kinds, having quite different-sized holdings and management objectives, the constructive use of forests may be difficult. The individual owner who wishes to handle his forest conservatively while the bulk of his neighbors prefers liquidation may win out eventually or be left stranded when the big mills close. Conversely, in a region where the bulk of the ownership is for recreational purposes, milling and marketing facilities often are poorly developed. Sometimes small owners find it impossible even to liquidate their holdings when they are disadvantageously located in regard to topography unless they can combine with others to make up economic operating units (Chapts. XV and XIX).

The prize example of a complicated and uneconomic forest-ownership pattern is found in western Oregon, where a great number of small holdings and a small number of very large ones are mixed indiscriminately with both large and small public holdings under four distinct administrations, and all boundaries are based on a rectangular survey having no relation to topography.[1] Since the region has practically no non-forest resources, its economic future is not assured until a solution whether by ownership consolidation, cooperation between owners, or overall public regulation is arrived at[2] (Part III).

The frequent failure of private forest ownership to produce socially valuable results, either for the reasons discussed above or because it is not always possible to make money by practicing forestry, is the primary reason for establishing public forests and for the public regulation of private forests (Part III).

Statistics of forest ownership for the United States as a whole (Table 10) are not in sufficient detail to permit a complete analysis of ownership because they do not break down private ownership except to separate farm woodlots from the grand total of private ownership.

TABLE 10

DISTRIBUTION OF OWNERSHIP OF COMMERCIAL FOREST LAND IN CONTINENTAL UNITED STATES, EXCLUSIVE OF ALASKA, 1936 [1]

Class of Ownership	Area (Millions of Acres)	% of Class	% of Total
Farm woodlots	138.8	41	30
Other private	202.1	59	44
Total private	340.9	100	74
State and local public forests	24.0	20	5
National forests	81.5	67	18
Other federal forest [2]	15.3	13	3
Total public	120.8	100	26
Total all classes	461.7	100	100

1 The United States Forest Service, *A National Forest Economy,* p. 98, 1939.
2 Indian reservations, public domain, and miscellaneous—National Parks not included.

Table 10 is evidence that in national terms no class of ownership is completely dominant even though the total of private ownership is

1 O. M. Butler, "The Oregon Checkmate," *American Forests,* p. 157, Vol. 42, No. 4, April, 1936.

2 J. B. Woods, "Moves on the Oregon Checkerboard," *American Forests,* Vol. 46, No. 10, p. 451, October, 1940.

nearly three times that of public. Regionally and locally the case is frequently different. Public ownership is more important in the West, where locally it frequently is dominant in area though not necessarily in volume and quality of timber (Fig. 22). Farm ownership is far more important in the East than in the West. Both public and farm

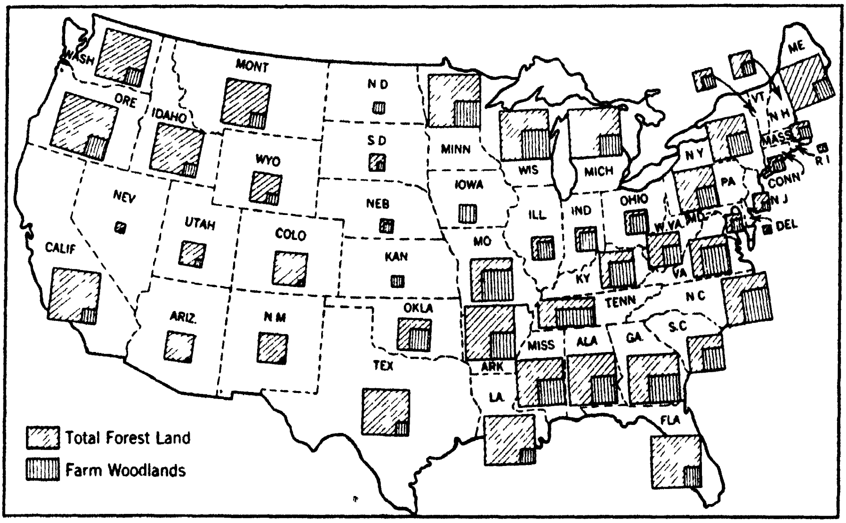

FIG. 22. Proportionate area of farm forests to total forests by states, 1930. [Courtesy, United States Forest Service.]

ownership of forests are increasing; the former by purchase, the latter by abandonment of submarginal farmland (Fig. 23).

12. FOREST DESTRUCTION

Forestry literature is full of descriptions of losses from forest destruction. Once the values of forests are grasped fully, these losses can be visualized easily. They fall into three main categories: (1) those to consumers of forest products formerly supplied by the region; (2) those resulting from the withdrawal of the protection and water-conservation qualities of the forest; and (3) those in the region itself.

The extent of losses to consumers varies with the difficulties of securing adequate supplies elsewhere. Since this usually involves drawing upon more distant regions or upon sources of an inferior quality, consumer costs are increased (Chapt. XII, Sec. 3).

The losses from floods and erosion vary more with the geology, topography, soil, and climate than with the form of the forest.

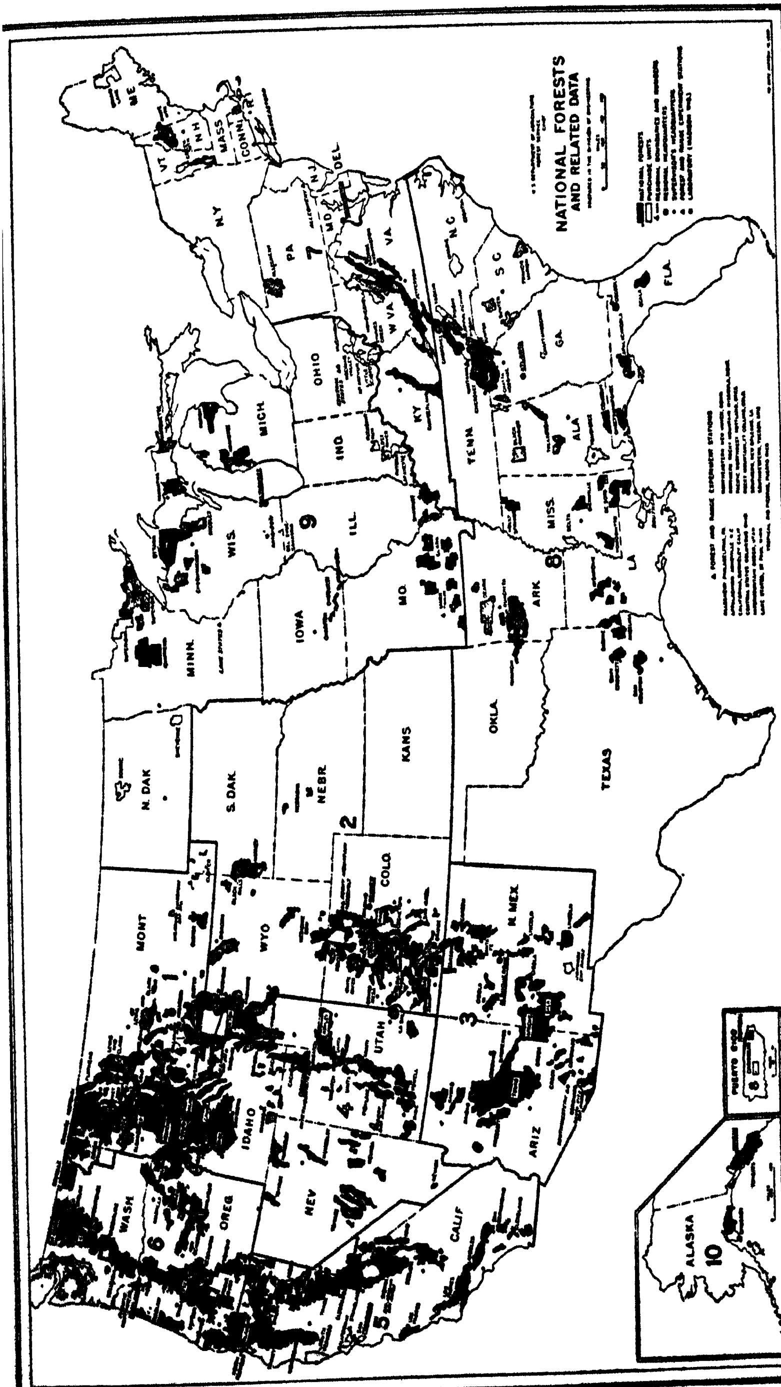

FIG. 23. National forests in the United States, 1940. Other federal forest areas are not shown. State forests are not shown. The largest areas of state forests are in New York, Pennsylvania, and the Lake States. (See also Chapt. XX, Secs. 3*B* and *E*.) [Courtesy, United States Forest Service.]

They are greatest in mountainous regions that have a high rainfall and an easily erodible soil. Also, they have the greatest effect outside the region itself (Sec. 6 and Chapt. XVI, Sec. 1). In flat counties with a firm soil, losses of this nature are at a minimum.

The magnitude of regional loss from forest destruction varies with the size of the area involved, the extent to which other resources are present, the degree of importance of forest influences within the region, and the length of time over which liquidation takes place. The longer this period, the longer the region has a productive resource (Chapt. X, Sec. 6).

The northern portion of the southern peninsula of Michigan is a classic of speedy and complete forest destruction and of subsequent poverty in a region without other important resources. It took only about 40 years to denude and completely destroy its great pine forests on some 10 million acres. (In rectangular form this would be an area approximately 200 miles long by 80 miles wide.) It was a period of hectic prosperity: population increased, towns were founded, roads and railroads were constructed, farms were established, and lumber barons built many mansions. This prosperity now is of only historic interest, but the losses from its collapse are still a charge on the economic and social books of the region, on the state of Michigan and the American people.

This loss has often been pictured in terms of barren stump lands, stretching farther than a car can travel on a full gas tank, over sand roads punctuated with ruined camp and mill sites and ghost towns. Sparhawk and Brush [1] paint a statistical picture of population decreases, loss in tax revenue, declines in freight tonnage, and similar depressing figures. Thinking in terms of people, Mrs. Armstrong [2] tells of social stagnation, appalling poverty, and degeneracy of the stranded population. She says, "Many . . . were so poor they did not even know there was a depression."

It is sufficient here merely to catalog the different kinds of losses. When the mills closed, the props dropped from under the income producing structure (Sec. 9*A*). The best of the woods and mill labor migrated; the local merchants and professional men did likewise or else

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[1] W. N. Sparhawk and W. D. Brush, *The Economic Aspects of Forest Destruction in Northern Michigan*, United States Department of Agriculture, Bulletin 92, 1929.

[2] L. V. Armstrong, *We Too Are the People*, Little, Brown and Company, Boston, 1938.

P. L. Buttrick, review of the above in *Journal of Forestry*, Vol. 36, No. 11, p. 1163, 1938.

suffered severe loss of income from diminished business. The laborers that remained tried to farm the sterile soil in competition with those already there who had managed so long as the lumber companies offered a market and part-time employment. Railroads, lacking tonnage, reduced schedules and finally abandoned service. The lumber companies, joined by disappointed landowners, brought new settlers, usually without much capital, to take the bankrupt lands off their hands. Thus they created further unemployment and relief problems for the overburdened communities. The loss in taxes from abandoned lands necessitated heavy taxation on such lands as remained productive, thus increasing universal bankruptcy with heavy debt charges on public borrowing. Finally the tax structure collapsed, organized township government frequently was abolished, and the state had to accept responsibility for tax-abandoned lands to the tune of over a million acres and had to subsidize bankrupt counties at the expense of taxpayers in other parts of the state. Meanwhile, once the largest lumber-producing state, Michigan, became an importing one—to the disadvantage of her woodworking industries, established on the basis of local supplies, and of her citizens who build homes and use wood products in other forms.

Despite work of state and federal agencies, the region has remained substantially unchanged for the last thirty years. It will continue unchanged, as far as anyone can see, unless vast amounts of capital are poured into reforestation on a grander scale than the American people are yet ready to consider or until the age-long processes of nature reclothe a vacant land which some one has called a "barrier to navigation between Lakes Michigan and Huron."

Fortunately the region still has the shores of its lakes, big and little; around them cluster recreation resorts, but even the hardiest vacationist avoids the desolate stumplands. Fortunately also the erosion problem is not serious except for local dune areas along the big lakes. There are denuded forest areas in parts of the South and elsewhere which if not so large or well publicized have no lake shores to attract recreationists but do have serious erosion problems. There are said to be 80 million acres [1] of forest land more or less completely devastated in the United States—or, if one prefers to think of it in another way, an area slightly larger than New York, Pennsylvania, and Ohio, combined.

[1] Copeland Report, Vol. I, p. 18.

CHAPTER X

THE ECONOMICS OF FOREST EXPLOITATION AND CONSERVATION

Forest exploitation may be defined as the process of removing timber crops from a forest, independent of whether the process is carried out on a liquidation basis or on a sustained-yield basis. It is necessary to understand the underlying economic factors involved in this exploitation before the economics of forestry can be understood. It is the purpose of this chapter to outline these factors. Since they are essentially the same for nearly all natural products or basic raw materials, it is well to begin by presenting the picture in broad outline.

1. THE SEARCH FOR RAW MATERIALS

All man's material needs must be supplied by the products of the earth, and much of his economic history concerns his struggles to gain possession of them. The basic problem has not changed in 10,000 years, nor can it ever change. It consists, first, in locating a supply; second, in gaining possession of it; third, in transporting it to the place of use; and, lastly, of preparation for use. In earliest history there were no transportation facilities other than the human back; so collection of materials was severely local. Their exhaustion meant that the tribe had to move to new sources. Hence, most primitive people were nomadic, following the seasons and the migrating game. When societies became rooted to one locality, exhaustion of local supplies had to be remedied by transportation from more distant sources, by the use of substitute materials, or by growing them at home. Despite human ingenuity in these respects, the struggle to obtain raw materials has increased in magnitude, intensity, and complexity, and has been one of the prime motives for exploration and discovery. Around it have revolved the struggles of high finance, international politics, wars of conquest, enslavement of native populations, and intricacies of trade. On its more constructive side, it has been one of the great incentives to science and invention.

In early modern history the materials most sought from distant sources were those of high value and small bulk, such as precious

metals, silks, furs, and spices. The large-scale transportation of bulky commodities, of bulky metals and timber, even by sea, was impossible in the small ships of the time and suitable land transportation methods were far in the future. It was not until the beginnings of the Industrial Revolution that land transportation developed sufficiently to permit much moving of bulky commodities. Consequently, their local shortage had to be met by local production or substitution.

By the time of the colonization of America the accessible forests of western Europe were pretty well exhausted. France and Germany began to grow forests. England, as a maritime power, commenced to import construction timber and turned to coal as a substitute fuel. Spain, intent upon developing a vast grazing industry at home and upon exploiting gold and silver resources in her colonies, accustomed herself to a scarcity of forest products.

The development of modern systems of transportation has made possible worldwide shipment of raw materials by land and sea. The problem of shortages has not been solved thereby, but the world is still very much preoccupied with the question of which is the best solution—conquest, trade, home production, or substitution.

The history of both local and worldwide exploitation of any renewable raw material divides itself into five more or less well-defined stages. The pioneer stage is characterized by an adequate supply, exploited only where it is most accessible. The trade is small, loosely organized, and indifferently financed, and methods of exploitation are crude and wasteful. The second or early industrial stage dawns when demand reaches a point which calls for larger organization, more capital, and greater efficiency in extraction. This results in greater profits and often in local exhaustion of supplies, but expansion into untapped regions makes up the difference. Continued growth of demand calls for larger and larger output, more efficient units of production, and greater capital investment. Eventual exhaustion of raw materials is foreseen, but little attempt to deal with it is made except by advancing prices and building up large stocks of materials against later need. This middle industrial stage leads into the capitalist-financier stage, and difficulties arise from many sources—overproduction, diminishing supplies, overcapitalization, loss of markets owing to substitutes, and public regulation. Decay or maturity may effect the final stage. Unless steps are taken by those engaged in the industry or by the public to prevent supply exhaustion, the industry dwindles to small proportions. If they are taken, production can be rationalized on the basis of conservation principles.

Chapter XI outlines the history of the American forest industries in terms of these stages. During all the stages, individuals, corporations, regions, and even nations compete to obtain and market supplies to their own advantage. The winners are those who can market the most cheaply and in greatest volume. Raw-material deposits are of value in proportion not only to their quality and size but also to their costs of exploitation. These costs are extraction, conversion, and transportation to market. The better their quality and the greater their amount, the lower is the cost of extraction and conversion. The more inaccessible their location, the more costly is their transportation. These matters are discussed in the following sections.

2. MARGINAL UTILITY AND DIMINISHING RETURNS IN FOREST EXPLOITATION

Costs of extracting and transporting raw materials are controlled largely by the economic principle of marginal utility and by the law of diminishing returns. A marginal product is one which, when sold, just meets its cost of production. Such a product is said to have a *marginal utility of zero.* Products yielding a profit are termed *supermarginal;* those resulting in a loss are *submarginal.* Under a given set of conditions a tree which, when cut, transported to the mill, sawed into lumber, and sold, just meets its cost of production is termed a *marginal tree.*

One aspect of the law of diminishing returns is the fact that, beyond a certain point, increased expense fails to increase profits even though it may increase output. The utilization of small tops and limbs in making cordwood increases the amount obtained from an area and also increases the cost of production. Carried beyond a certain point, it reduces profit and finally causes a loss.

The idea of the marginal tree can be understood more easily if the following points are kept in mind.

1. The volume of a tree or log increases with the square of its median diameter. Consequently, it may take several small logs to equal a single large one.

2. The proportion of high-grade material usually increases with the diameter of the log because knots are buried more deeply in the wood and serious decay is more likely to occur in the center of a log than near its surface. Figure 24 shows the percentage of grades obtained from sugar maple logs of different diameters.

3. Although the cost of felling, transporting, and sawing logs naturally increases with their diameter, the accelerating rate of volume

increase of logs of large diameters makes the cost of producing lumber from them less. The greater percentage of their high-grade material increases their value still further. However, it must be noted

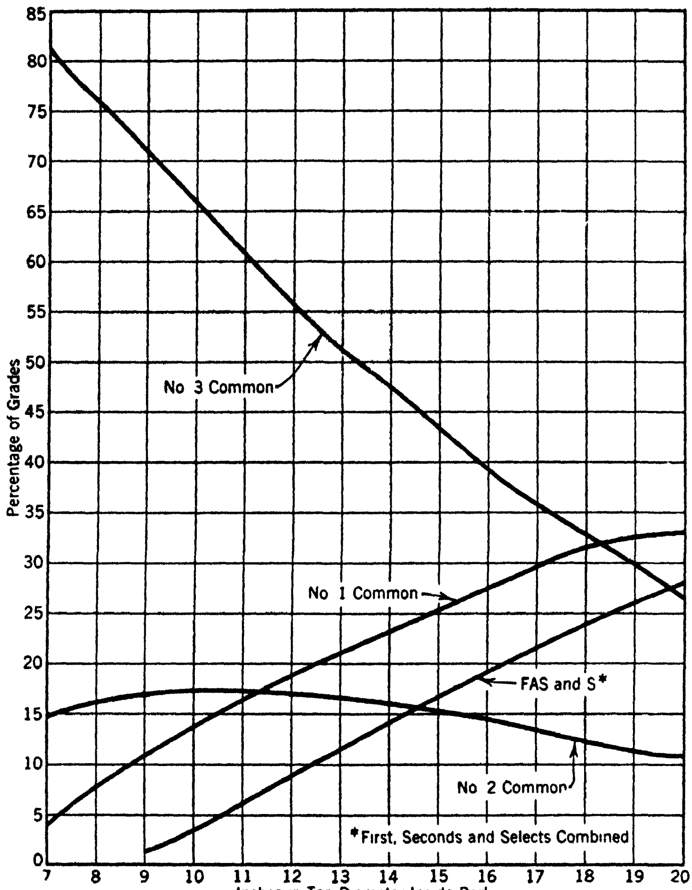

FIG. 24. Percentage of high-, medium-, and low-grade lumber obtained from sugar maple logs of different diameters in the Lake States. Grades in descending order of value are: firsts, seconds, and selects, No. 1 common, No. 2 common, No. 3 common. (The same general relations of grades to size of logs prevail in all species.) [From R. Zon and R. D. Garver, *Selective Logging in Northern Hardwoods*, United States Department of Agriculture, Technical Bulletin 164, 1930.] (See also p. 186.)

that the greater cost of handling very large logs somewhat increases the cost of producing lumber from them. This difference usually is offset by greater value, owing to the higher grade of lumber.

All these points are illustrated graphically in Figs. 25, 26, and 27. Figure 25 shows the generally decreasing costs per thousand feet of board measure of felling, skidding, and hauling for trees of increasing diameters. The operation is in western white pine in Idaho. (See also page 194.) Figure 26 is a time study showing the increasing length of time necessary to saw logs of increasing diameter but the much more rapid decrease in the time necessary to saw a given quantity of lumber as the logs increase in size. Since time, economically

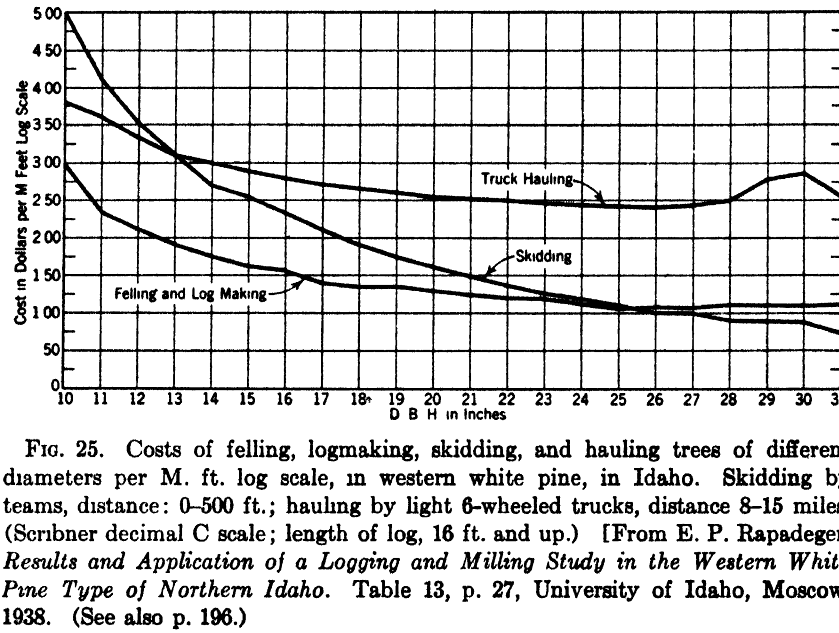

FIG. 25. Costs of felling, logmaking, skidding, and hauling trees of different diameters per M. ft. log scale, in western white pine, in Idaho. Skidding by teams, distance: 0–500 ft.; hauling by light 6-wheeled trucks, distance 8–15 miles. (Scribner decimal C scale; length of log, 16 ft. and up.) [From E. P. Rapadeger, *Results and Application of a Logging and Milling Study in the Western White Pine Type of Northern Idaho.* Table 13, p. 27, University of Idaho, Moscow. 1938. (See also p. 196.)

speaking, is money, if we knew the cost of operating the mill, it would be easy to translate the data in Fig. 26 into cost curves.

Note the tendency of all these curves to level off or rise as the larger diameters are reached. It indicates rises in cost due to the increased weight and bulk of the logs. Figure 27 shows the total cost of production and the sale value of lumber in terms of log diameters in shortleaf pine in Arkansas. It will be noted that the total cost of production declines to a minimum at 18 in. d.b.h.; thereafter it rises slightly. The value increase, however, more than offsets it and profit augments with diameter increase as far as the curves go. From this figure it appears that a log of 9 in., top diameter, yields a profit; one of 8 in. results in a loss. A log of 8.6 in. (the precise point of crossing of the curves) was, therefore, the *marginal log* at the time and

place of the study. Any tree in the woods which did not contain at least one such log was a *marginal tree.*

Since the profits on a 9-in. log were very small, a 9-in. tree of poor quality would probably have been considered marginal. As the cost of bringing logs to the mill obviously increases with the distance and

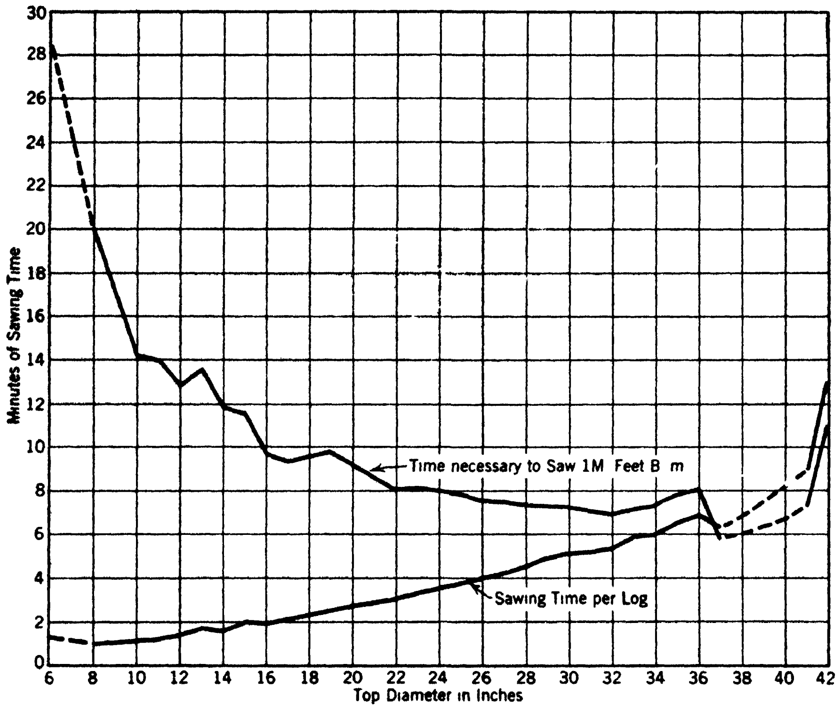

FIG. 26. Average time necessary to saw 16-foot western pine logs of different diameters compared with length of time necessary to saw 1 M. ft. b.m. of lumber from similar logs of the same species and range of diameters. [From Swift Berry, "A Study of the Grades of Lumber Produced from California Pine, Fir, and Cedar," *The Timberman,* p. 39, April, 1938.] (See also p. 193.)

difficulties of transportation, the size and other qualifications of the marginal tree and log either must be continuously raised to meet the added cost as logging is progressively carried into more difficult and distant terrain or must be set to meet the average distance and logging conditions for a given job or region. Therefore, *the commercial value of a tree depends upon the combined factors of size, quality, and location with reference to market.*

All logging, milling, and transporting operations are conducted with regard to the marginal tree. The small operator is apt to determine

it on the basis of experience; large operators do it by the use of elaborate systems of cost accounting, mill tallies, and mathematical formulae.[1]

The practical working of the principle of marginal utility and diminishing returns may be seen on any logging operation. Where the terrain is rough and the method of transportation primitive, the number of small and low-grade trees and upper logs which are left in-

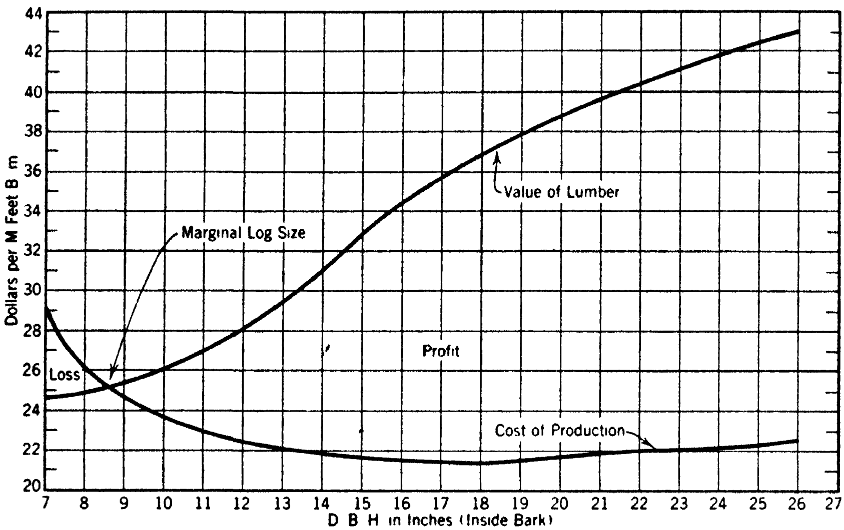

FIG. 27. Comparison of cost of production and value of shortleaf pine logs of equal length classified by diameters. The unit of measure is 1 M. ft. b.m. [From R. D. Garver and R. Miller, *Utilization of Shortleaf Pine at Small Mills, Ouachita National Forest,* Tables 10 and 15. Mimeograph Circular, United States Forest Service, 1928.] (See also p. 193.)

creases progressively from the point of primary concentration[2] as the topography becomes less favorable for transport. If the job is on level terrain with a good bottom or if a mechanical system of skidding is used, there is little difference in the size of timber left throughout the area since, under these conditions, the added factor of distance is less important.

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[1] For a discussion of mill tallies, see Chapter XVIII, Section 3C. For formulae see D. M. Mathews, *Cost Control in the Logging Industry,* McGraw-Hill Book Company, New York, 1942.

[2] By point of concentration is meant the skidway, landing, railway siding, or river bank where the logs are concentrated for delivery to the major transportation system to the mill. In the operations of portable mills where the logs are skidded directly to the mill, the millyard is the concentration point.

On practically all jobs it will be observed that, where the timber thins out so that the trees above the margin are limited in number and widely scattered, they are likely to be left because their cost of logging exceeds their value. In other words, the outlying stands are themselves submarginal. A stand, like a tree, may be marginal because of size, quality, or location. Despite its location, it is submarginal if it does not contain enough trees above marginal limits to justify logging. It will be submarginal despite its size and quality if it is located so that it cannot be logged at a profit. Such stands are called *inaccessible*. This term may be used in a physical or an economic sense. There is not much good timber left in the United States which is physically inaccessible. America has developed transportation and logging systems that are adequate to deal with almost any bodies of timber, but there is still much timber which is economically submarginal. It includes not only timber in remote regions but also many small patches on difficult topography in long-settled areas.

We also have to deal with marginal grades of lumber. The percentage of low grades of lumber far exceeds that of high grades (Fig. 24), and there is a great differential in their prices. (The price of the highest grade in extreme instances may be as much as ten times the lowest.) The cost of transportation varies with the distance but seldom with the grade. Therefore, at a given scale of manufacturing and shipping costs and of lumber prices, it may not be possible for a mill or region to ship profitably lower-grade lumber to distant markets. Hence these lower grades are marginal for the particular mill or region as far as the distant market is concerned. The lower the quality and size of logs used, the greater the distance to market, and the lower the scale of prices, the more important this factor becomes.

In different regions that sell comparable lumber in the same market, the marginal tree will be of greater diameter and of better grade in the higher-cost region. Thus, in the southern pine region the marginal tree is much smaller than in the Douglas fir region of the Pacific Northwest although both regions sell on a competitive basis in the eastern market. Species growing side by side often have quite different margins, depending on the price of their lumber. For example, beech in Wisconsin in 1938 sold at about $5.00 per thousand less than hard maple.[1] Consequently, the beech margin was higher than the maple.

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[1] *Forest Products; Lumber, Lath and Shingles,* United States Department of Commerce, 1938.

Any change in the relative cost of production and transportation to selling price changes marginal standards. If the selling price of a marginal grade of lumber increases sufficiently so that it more than meets shipping costs, it immediately becomes merchantable. Figure 28 illustrates this by showing the percentage of sales of a marginal

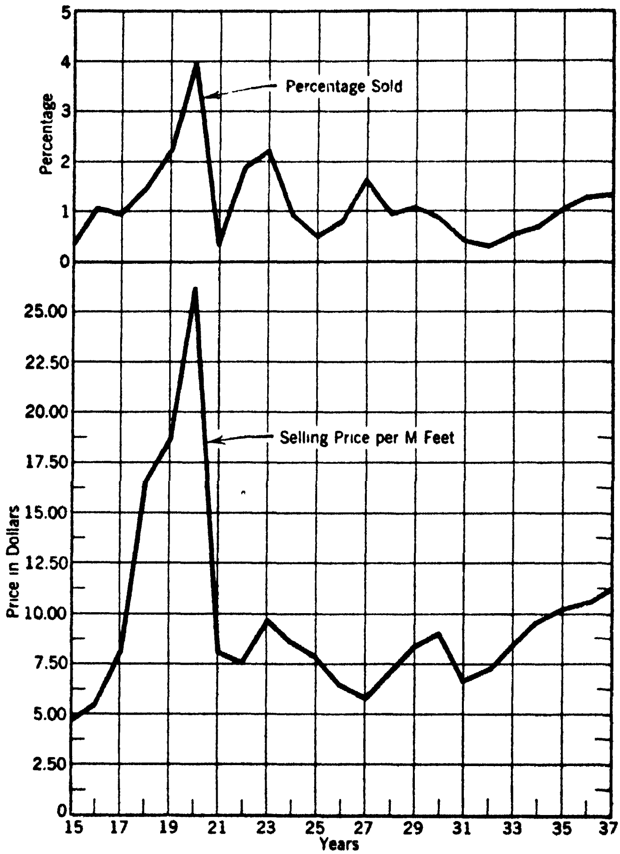

FIG. 28. Selling price of a marginal grade of lumber compared with the percentage sold (1915–1937). Confidential figures from a group of mills in the same regions.

grade in comparison with its selling price. It will be noted that the percentage sold usually increases with the price, indicating that at low-price periods little is manufactured. The exception in 1927 is due probably to the disposal of accumulated stock of previous years regardless of prices.

Since most of the logs containing this lower-grade material must be brought in and sawed to obtain the higher grades, there is little change

in cost of operations. If, however, the price of all lumber goes up sufficiently, smaller and lower-grade logs can be brought to the mill and the standard of marginal log and tree decline, but the cost of producing the added lumber will be increased as the log size and grade decrease (Fig. 26). Unless prices increase indefinitely, the law of diminishing returns operates, and rising costs again set a new margin. The long-range trend of margins in America has been downward. Trees are being cut, logs sawed, and lumber sold, of sizes, grades, and species that formerly were completely unmerchantable. This has been due not only to price rises and cost reductions but also to progressive exhaustion of higher-grade material, the introduction of improved logging and milling equipment and, until recently, the rapid expansion of demand (Chapt. XII, Sec. 1).

This discussion of margins has been written around lumber, but it is applicable to all forest products. There are certain standards of size, grade, and species which can be utilized for any product under a given set of production methods, costs, and selling prices, be the product telephone poles, pulpwood, or turpentine, or anything else that comes from a tree. As they change, so do the standards.

3. ECONOMICS OF FOREST-PRODUCT TRANSPORTATION

In dealing with transportation the following should be remembered. (1) The greater the value of an article, the greater the transportation charge it can stand. Mahogany, having a high luxury value, can be packed out of tropical jungles on the human back and shipped half way around the world. Conversely, the greater the transportation charge on an article, the greater becomes its price to the ultimate consumer. Firewood, shipped 200 miles, also becomes a luxury product. (2) Within the limits of practicability in handling, the larger the container, be it freight car, truck, or ship, the less will be the unit cost of transporting commodities when it is operated with a capacity load. For this and other reasons of a mechanical and financial nature, transportation by water is generally cheaper than by land. The rule also holds in principle, as between rail and truck shipments. A freight car carries more than a truck, and trucks cannot be made into multiple units like freight cars. However, for short distances, the lower capital charges and greater flexibility of trucks frequently makes them the less costly shipping method, particularly for small loads.

It is difficult to overstress the importance of transportation in forest exploitation. Logging itself is essentially a transportation process,

beginning the moment a tree is converted into saw logs and ending when its lumber reaches the ultimate consumer. The same is true of all forest products.

Transportation usually goes through three stages: the assembly of the logs at concentration points (skidding); their conveyance in larger loads by a different form of transportation to the mill (log hauling); the transportation of lumber to market (lumber shipping). Each is subject to different conditions. Skidding is nearly always done by the operator over roads of his own construction and with his own equipment. If the area is remote, he must also construct his own road and furnish his own equipment to transport logs from skidways to the mill. If located near a drivable stream, he may use that. If operating in a country with a good system of public roads, he can truck his logs to his mill. The more transportation ways and equipment he has, the greater his investment cost in relation to his operating cost, but in all cases he has some control over methods and costs. In lumber shipping, however, he has no particular fixed investment, for lumber usually moves by common carrier; but he has little, if any, control of costs or schedules.

Transportation of logs from the stump is essentially a process of collecting them in progressively larger quantities at concentration points, the final point being the mill. A logging transportation system, plotted on a map, looks like a drainage system which, in fact, it is—a system for draining logs out of an area. So far as possible, it follows natural drainage courses since, with rare exceptions, it is much cheaper to move materials downhill than uphill, regardless of the system used.

Consideration of the facts presented on p. 188 makes it evident that the more timber obtained from an acre, the lower the cost per thousand feet, *until the size of the log falls so low that there is an increase in the unit cost per log sufficient to raise the unit cost per thousand feet.*

Assume two areas similar in transportation difficulties and distance to a skidway. One runs 5 M. ft. b.m. per acre and the other 20 M. ft. b.m. Obviously it will be necessary to work four times as much area to get the same amount of timber from the 5-M. ft. b.m. tract as from the 20-M. ft. b.m. tract. Therefore, transportation will cost about four times as much on the first area as on the second for the same volume of timber, and the cost per thousand feet will be less on the 20-M. ft. b.m. area.

An example of the increase in cost of skidding per thousand feet for small trees as compared with large trees may be taken from Mathews.

He has figured that under conditions assumed to prevail in a stand of hemlock and hardwoods in the Lake States, running 10 M. ft. b.m. per acre, the cost of skidding, cutting to a 10-in. d.b.h. limit, would be $1.44 per thousand feet board measure; raising the diameter limit to 18 in. would reduce the cost to $0.95 per thousand feet board measure, the volume of timber removed being about one-half as much.[1]

The same general factors hold in transportation from concentration point to mill but, when it is necessary to build an expensive transportation way, the investment factor becomes of great importance. Assume that it is necessary to build a road, costing $20,000, to reach a tract of timber. Unless the road has other revenue-paying uses, it must be paid from the sale of the timber. If there is not enough timber for this purpose, it is submarginal until lumber prices go up, until other costs go down, or until a cheaper means of logging is devised. The cost of timber removed over this road can be determined at so much per thousand feet. If there had been twice as much timber on the area, the cost of the road per thousand feet would have been one-half as much.

Naturally, the better a transportation route, the cheaper it is to operate. Therefore, the successful logger must determine the most effective ratio between investment in the building of transportation ways and their cost of operation in order to move his logs at the least cost. The use of power-logging machinery is dominated by similar considerations. Its superior efficiency to animal, or even to tractor skidding, under some conditions can be realized only when the volume of timber to be moved is great enough to justify the investment required and when the timber is sufficiently concentrated so that time is not lost in frequent changes in set-up.

The minimum cost of logging, other things being equal, is attained over country with a hard bottom, free from obstructions, and where the general slope is moderate and in the direction toward which the logs are to be moved. The construction of and operation on roads for the removal of logs from skidway to mill are also lowest under these conditions. The more topographic irregularity—soft bottom, swamps, and the like—the greater the cost. However, if the volume to be moved on a difficult terrain is sufficiently high, the cost per thousand feet may be less than for a lower volume on an easy one.

One more factor regarding log hauling remains for comment. Skidding is more or less a proposition of dragging individual logs on the

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[1] D. M. Mathews, "Financial Aspects of Forestry in the Lake States," *Journal of Forestry*, Vol. 37, No. 9, p. 712, September, 1939.

ground; log hauling is an operation of moving logs in vehicles. In log hauling it is unfortunate that logs are round and tapering, for there must always be waste space in the vehicle in which they ride. If logs were perfect cylinders, the percentage of waste space would be approximately constant, regardless of size, provided that all logs on a load were the same size; but the taper in logs increases waste space with the decrease in diameter. This results, of course, in vehicles' being undercharged in weight when only small logs are handled. When products such as pulpwood are handled, where practically the entire volume is used, the factor is of less importance than with saw logs where the waste in manufacture is higher. Table 11 shows how this principle works out on the job.

TABLE 11

RELATION OF LOG DIAMETER TO LOAD CAPACITY OF MOTOR TRUCKS [1]

(Based on Performance of 6-Wheeled Light Trucks)

Log Diameter inside Bark (In.)	Logs Hauled per Load	Volume per Load (Bd. Ft.)
6	59.5	1190
10	40.0	2400
14	25.5	2805
18	14.0	2940
22	9.0	2970

[1] *Results and Application of a Logging and Milling Study in the Western White Pine Type of Northern Idaho,* University of Idaho Bulletin, Vol. 33, No. 16, p. 49, July, 1938.

The cost reduction involved in handling larger logs is expressed here in the curve, "cost of truck hauling," in Fig. 25. It is obvious from the above that to ship a given footage of lumber is cheaper than to ship the logs from which it is cut, not only because lumber can be loaded with less waste space than logs but also because the waste in the form of slabs, edgings, and decayed material, has been removed and, if it is shipped dry, the weight is still further reduced. Therefore, the nearer the mill can be set to the timber, the more the resulting economy.

When the lumber leaves the mill for a distant market, it is shipped nearly always by rail or water or by both rail and water. The fact that the manufacturer usually sells it at the mill to wholesalers or to large industrial consumers does not lessen his interest in the cost of shipment—the purchaser deducts this cost in one way or another.

The magnitude of this shipping charge may be judged by the fact that in 1937 the freight bill on lumber shipped on Class I railways of the United States was $148,238,248.[1] This amounted to about $1.15 per inhabitant of the country. The freight bill for all forest products transported on Class I railways in 1937 was $225,537,445,[2] or about $1.70 per capita. If to this were added the cost of ocean and inland water shipments and other land carriers besides Class I railways, the charge would be much greater.

Certain other value relations are brought out in the following quotation:[3]

> In 1936, 21.08 per cent of the value of lumber, lath and shingles at destination was spent for freight, according to a special report of the (Interstate Commerce) Commission,[4] compared with 15.38 per cent of the value of all forest products. The value at destination is given by the I.C.C. as $32.70 per ton for lumber and the freight cost per ton as $6.89 in 1936. Based on weight of 2,600 pounds per M feet, the rail freight cost in 1936 was $8.96 per thousand feet, which was 42 per cent of the average mill price as reported by the Census Bureau ($21.47).

It is easy to see that this freight charge adds greatly to the cost of lumber to the consumer, particularly those consumers at the greatest distance from the producing regions. Conversely, advantage naturally goes to those mills and regions where the freight charge to market is least. Transportation companies, not being in business for their health, charge "what the traffic will bear," except as their rates are modified by competition, and desire to increase their business, and organized pressure from shippers and communities, and public regulation. As a result, rail rates are based on a number of considerations besides weight, bulk, value, and distance, which the man from Mars might be expected to think the only pertinent criteria. The influence the shipper has over rates is such as he, individually or through association with others interested in the same thing, can exert on the railroads directly or through the Interstate Commerce Commission, which has certain regulatory powers in regard to them. The result

[1] Interstate Commerce Commission, freight commodity statistics, as quoted in Table 32, *Lumber Industry Facts,* National Lumber Manufacturers Association, 1939.

[2] *Ibid.*

[3] *Lumber and Timber Information,* National Lumber Manufacturers Association, 1938.

[4] *Freight Revenue and Value of Commodities Transported on Class I Steam Railways in the United States in 1936,* Statement 3747, File–18 C–23.

is, for the layman, a complete maze of inconsistencies and special cases. Even the expert in railroad rates is at a loss to explain them logically, as he tacitly admits by speaking of a rate structure rather than of a rate system.

Into this rate maze we shall not enter, being content to state that lumber and forest product freight rates generally are based primarily on weight (100 pounds being the unit for lumber) and bulk, which is taken account of by raising the rate for the shipment of dimensions which require two cars or do not load one to its weight capacity. Light-weight woods which fill a car but do not utilize its full weight capacity are therefore more expensive to ship than heavy-weight woods. Value is accounted for by classifying forest products in certain broad groups; these groupings do not extend generally to grades or often to species.

TABLE 12

COMPARATIVE LUMBER RATES FROM SEATTLE, WASH., AND ALEXANDRIA, LA., TO CHICAGO, ILL., 1887–1919 [1]

(Cents per Hundred Pounds)

Year	To Chicago, Ill., from	
	Seattle, Wash.	Alexandria, La.
1887	60	22
1893	50	22
1899	50	23
1900	50	24
1903	50	26
1908	55	26
1917	55	26.5
1918	60	31.5
1919	60	32.5

[1] A. G. T. Moore, *Transportation As a Factor in Forest Conservation and Lumber Distribution*, p. 18, Yale University School of Forestry, 1937.

For short-distance hauls the rate is likely to be in a more or less direct relation to the distance. As distance increases the rate has a tendency to drop irregularly. For very long distances rates of commodities between producing and consuming districts are often "blanketed"; that is to say, a uniform rate prevails from all the shipping points in a producing territory to all the receiving depots in a consuming territory. Such blanket rates prevail from the southern

pine territory on the Gulf Coast and the Douglas fir territory of the Northwest into the central and northeastern states.

This equalizes shipping costs for mills of each region into their common market, which is the largest in the United States, and standardizes the so-called "freight differential" between these major producing regions. It naturally follows that the mills in the more remote regions try to obtain reductions in this differential which, because of greater distance, is generally unfavorable to them; while those in the less remote regions attempt to retain or increase what is to them a favorable differential. Rates change frequently for this and other reasons, giving a competitive advantage sometimes to one region and sometimes to another. Table 12 is of interest in this connection.

As these rates change in favor of one region as against another, marginal standards in mill and woods must change to make the necessary adjustments. Since the freight rate bears the most heavily on the lowest grade of lumber, which seldom has much if any better rate than the more valuable grades, the lowest grade is the most affected.

It is evident that a competitive disadvantage in shipping costs, so long as those costs remain fixed, can be overcome only by sufficient reductions in other costs of production, by competition based on a quality or service basis, or by discovering a cheaper method of transportation. None of these may be possible. It depends upon all the factors involved. In the Douglas fir region much lumber passes through the Panama Canal to reach the north Atlantic Coast, thus reducing the differential to some extent by taking advantage of cheaper water rates.

4. "THE MARGIN FOR STUMPAGE"

The purchase cost of raw material is the first link in the chain of costs of producing finished articles. However, the value of raw material cannot be determined until the costs of its extraction, manufacture, and shipment have been estimated and compared with the probable selling price of the finished product.[1] A man, not knowing the selling price of lumber or its production cost, would have no criteria for determining how much to pay for a timber tract to be exploited commercially. Any price he might pay would be a gamble.

[1] When raw materials are rare, competition may force up their price, and the resulting increase in total cost may be passed on to the consumer. Since there are limits to what consumers can or will pay, the process has limits, and the essential truth remains that the raw-material price is finally dictated by costs of production and by the selling price of the finished product.

The value of stumpage is determined by estimating all costs of production, fixed and variable, adding a sum which represents desired profit with allowance to cover risk of the enterprise, and subtracting the total from the expected selling price of the timber (Chapt. XVIII, Sec. 1). The resulting sum is the so-called "margin for stumpage." Stumpage may be purchased for current or future use or for speculation. When purchased for current use, cost of production and selling prices can be closely estimated. For the future, forecast is difficult. Consequently, purchases for immediate use can be made with a lower risk margin. The longer the period before use, the higher should be the risk margin, but by purchasing only for current use the operator sacrifices any chance of forestalling a rise in the price of stumpage itself and may not be able, if prices do rise, to continue to buy on profitable terms. For this reason only portable or small stationary mills (Sec. 5), operating in regions where timber is held in small tracts by owners who are willing to sell at any time, can take the risk of purchasing stumpage in small lots as needed. The larger operators must protect their investment and the continuity of their operations by purchasing large quantities of stumpage for future use. This usually involves the acquisition of land as well as of timber, increases investment cost, and introduces the elements of carrying charges in the form of taxes, interest, and protection costs. The larger the operation, the greater the investment necessary for acquiring and holding stumpage reserves. Therefore, a larger and larger risk margin must be estimated, and the greater is the danger of severe loss if it is not adequate to cover unanticipated increases in costs or decreases in selling prices. In other words, stumpage purchase passes progressively from a current expense to an investment and then to a speculation with the size of the purchase and the lapse of time before its conversion is complete.

5. FACTORS AFFECTING OPERATING UNITS

Because the exigencies of log transportation require that a sawmill be located near its timber supply (p. 196), its capacity must be adjusted to stumpage available. Three general types have evolved to meet this adjustment: the *community* or *custom* mill; the *portable* mill; and the *industrial* or *merchant* mill.

The community mill is the descendant of the village sawmill of early America (Chapt. XI, Sec. 1). Its location is permanent, its equipment simple, and it often combines lumber manufacture with grist milling, wood turning, or similar operations. Such mills commonly purchase logs rather than stumpage; the sellers, usually farm-

ers, generally make delivery. Sometimes the farmers pay to have their own logs sawed, utilizing the lumber themselves. This is called custom sawing; hence, the term "custom mill." Such mills represent but small investment. They can exist only so long as timber remains within economic hauling distance. Their range of operations is increased only as roads improve and open up new supplies or as prices increase. The cost of log hauling tends to keep their cutting margins at high diameters, which, to some extent, promotes conservative cutting in sections where they are the only operators. Their output, individual and combined, is small and is locally used.

The portable mill is moved as logging proceeds. Therefore, it is able to take the fullest advantage of the economies inherent in moving lumber as compared with logs. It is set in or close to the timber, and the logs are skidded directly to it, the lumber being trucked over existing roads to its distributing point. The investment in transport ways is therefore practically nil. The adjustment of capacity of the mill to amount of timber is simply one of figuring the minimum amount which will justify a set-up and the maximum that can be handled profitably. Since the capital investment is small, often only a few hundred dollars, if timber is temporarily unavailable or the lumber market is poor, a portable mill can shut down with little loss. Consequently, they are able to operate at extremely low cost and on a very small profit margin. All this enables them to cut to very low diameters. Their owners are usually men without large financial resources. The mills are often mechanically inefficient and their product in consequence even though cheap to produce is often poor in quality and usually sells only locally. Individually their output is small, but since there are thousands of them, collectively it is large.

Portable mills are unable to operate efficiently in large tracts, remote from existing transportation, or to produce large quantities of lumber on a fixed schedule to definite standards. The answer is the industrial mill with its heavy capital investment in transportation and equipment. Mill capacity varies with the amount of timber to be cut and the time during which the cutting is desired. The one may run from a few thousand to a million or more acres, the other from 5 to 30 years. Whatever the size, adjustment must be secured by control of sufficient stumpage to amortize profitably the full investment cost. This usually means outright purchase of land and timber for which the corporation usually must go heavily in debt. Since industrial mills must make large investments in stumpage,[1] they are exposed to the

[1] Operators of large mills in the vicinity of national forests at times may purchase stumpage on a royalty basis from the government and overcome this

risks discussed on p. 200 and are also under the handicap of being obliged to scrap their mill and logging improvements when they have cut their last log, often before they are physically obsolete.

Nevertheless, they have operated successfully to produce lumber in abundance and, in the main, profitably. They constitute the industry as we think of it ordinarily. Their owners make up the membership of the national and regional lumber associations which integrate trade policies, influence legislation, conduct research, and represent the industry before the public.

The custom and portable mills are almost completely unorganized, yet their very low cost structure often enables them to market lumber more cheaply than the industrial mills. According to the Southern Pine Association, the average production cost of their member mills [1] from 1921 to 1930, including stumpage but not interest, was $24.45 per thousand feet board measure. During the same period the cost, including stumpage at an average portable mill operating in the same region, was estimated at $17.30 per thousand feet board measure.[2]

Although the industrial mills produce the bulk of the country's lumber, the percentage is declining. The separate production of custom, portable, and industrial mills cannot be determined, as the United States Census Bureau does not classify them according to these types, but by utilizing its figures for cut of mills by size classes it is possible to make a fairly close estimate of percentage of cut from industrial mills, hereafter called "large mills," and portable and custom mills together, hereafter called "small mills." [3]

The Census Bureau divides mills into eight different classes according to the size of their annual cut, as follows:

Class 8:	Cut over	50,000	M. ft. b.m.			
Class 7:	do.	25,000	do.	to	49,999	M. ft. b.m.
Class 6:	do.	15,000	do.	do.	24,999	do.
Class 5:	do.	10,000	do.	do.	14,999	do.
Class 4:	do.	5,000	do.	do.	9,999	do.
Class 3:	do.	1,000	do.	do.	4,999	do.
Class 2:	do.	500	do.	do.	999	do.
Class 1:	do.	50	do.	do.	499	do.

(Mills cutting less than 50 M. ft. b.m. are not included.)

heavy investment, although often at increased operating cost (Chapt. XVIII, Sec. 2).

[1] All industrial mills.

[2] *Economic Conditions in Southern Pine Industry,* Southern Pine Association, New Orleans, Louisiana, pp. 53–57, 1931.

[3] This grouping probably takes in a certain number of small industrial mills, but this does not invalidate the conclusion that an increasing percentage of the country's lumber comes from small mills.

Classes 1 to 4 may be considered small mills; the others, large. The following tabulation[1] shows the above percentage of cut by mill classes.

Year	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*
1924	22.7	22.1	14.0	9.2	9.6	13.2	4.9	4.3
1926	26.1	22.0	13.5	7.3	8.2	13.6	5.0	4.5
1928	28.3	22.3	11.8	7.3	8.0	13.0	5.4	3.9
1929	25.8	20.4	11.1	6.9	8.1	15.0	6.6	6.1
1930	21.6	23.3	13.1	7.4	9.4	12.5	6 1	6.6
1936	21.6	19.4	11.4	6.2	10.6	18.4	6.3	6.1
1938	15.8	16.4	12.9	7.0	10.8	22.1	7.1	7.9

In 1924, 68 percent of the cut was from large mills; 14 years later, only 52 percent. It varies greatly between regions. The greatest number of mills of the largest classes is in the Pacific Coast and Rocky Mountain region and in the southern pine region. The change in percentage of cut by large and small mills between 1924 and 1938 for these two regions is as follows:

	% *Large Mills*			% *Small Mills*		
Region	*1924*	*1928*	*1938*	*1924*	*1928*	*1938*
Pacific and Rocky Mountain	91.2	89.8	81.7	9.8	10.2	18.3
Southern pine	58.7	47.1	27.9	41.3	52.9	72.1

This tendency toward decreased production in large and increased production by small units is contrary to that of industry in general, which has a tendency progressively to concentrate its production in fewer and larger plants. The chief reason for the unusual trend in the lumber industry is the gradual exhaustion of tracts physically and economically suited to exploitation by larger mills. This decline probably will continue[2] and eventually cause considerable reorienting of the industry, as is further evidenced by the fact that recently the product of portable mills in the southern pine region has begun to find its way into the northern market in competition with that of the large mills.[3] This is accomplished by trucking rough lumber from the portable mills to finishing plants where it is finished and rail-shipped to distant markets. This system may spread to other regions where commercial second-growth timber is abundant and the highways are

[1] Percentages computed from census reports. See References, Chapter XII.

[2] It has also occurred in Canada. See A. R. M. Lower, *The North American Assault on the Canadian Forests,* Chapt. XV, The Ryerson Press, Toronto, Canada, 1938.

[3] As long ago as 1930, it was estimated that 50 percent of the cut of the southern pine region was from portable mills. Southern Pine Association, *op. cit.*

good enough to permit economical transportation of the rough lumber over a radius sufficient to concentrate a considerable volume of material at one point.

The portable mills are often looked upon with disfavor by the larger lumbermen and by foresters because they reduce prices below the profit margin for the larger mills, are frequently a factor in overproduction, and are unwilling to assist in the various stabilizing moves and trade-expansion activities of the industry. They often cut immature timber, their operations are usually excessively wasteful, and their inefficient sawing often produces lower-grade lumber than necessary. Furthermore, their owners often take advantage of the seller's ignorance and pay too little for stumpage, thus discouraging interest in forestry. By paying substandard wages, they contribute less than they might to local economy. Nevertheless, they appear to be the logical means of utilizing the forest resources of large portions of the country, and they have important economies of operation. Mechanically improved and run by interests with somewhat more capital and a broader social and economic viewpoint, they are capable of being turned into important agencies for the practice of forestry and the promotion of community welfare, as well as for the production of large amounts of lumber. The persistence of custom mills, particularly in the Northeast, suggests that their peculiar economies may be worthy of study by foresters in other regions.

6. THE EFFECT OF MARGINAL CUTTING ON FORESTS

Since logging must be conducted with reference to marginal standards at the time and place (Sec. 2), the relation of these standards to the quality of the material in the forest determines the severity of the cut. When standards are high and quality low, only light *selective* cuttings are economically possible, thus leaving the forest substantially intact. If standards are low, it is often possible to *clear-cut*,[1] which in the absence of definite provisions for reproduction may destroy it utterly. Independent of economic factors, some forests are adapted to selective and some to clear cutting. Multi-specied, all-aged stands, because of their many small-sized trees and species of varying values,

[1] The terms "clear-cut" and "selective" (above) are here used as the logger uses them and without any reference to their use in forestry, where they are employed to describe methods of cutting designed to secure reproduction. Sometimes the needs of the logger and the forester are such that each requires a different sort of cutting, sometimes the same system satisfies both. Usually forestry requires some modification of the ordinary logging method (Sec. 7).

are likely, even under excellent price and other conditions, to contain considerable submarginal material; whereas, mature, even-aged, pure or nearly pure stands are generally made up of larger trees, the bulk of which is about the same size and quality and therefore can be clear-cut under much less favorable price conditions.

Early American logging, except for agricultural clearing, was largely selective, regardless of the form of the forest. The gradual increase in demand caused a lowering of standards, and areas were continually relogged to take lower and lower diameters and poorer and poorer species. Later, those forests which were suited to it were clear-cut and others were selectively logged to varying intensities. Finally, with the introduction of railroad and power logging, it became possible to clear-cut large areas regardless of their form. This usually resulted in the destruction of the marginal material that, under older systems, might have continued to grow. The economic result has been either a slow or a rapid destruction of forest values. The processes of deterioration in some places and destruction in others can be studied from the United States Census figures of the cut by species from the different states. Two very instructive comparative studies are between Maine and Michigan, and Georgia and Louisiana.

Figure 29 contrasts the white pine output in Maine and Michigan. Originally in both states it was practically the only tree worth logging. In Maine it generally occurred mixed sparingly in all-aged forests of spruce, balsam, and hardwoods; in Michigan it was chiefly in pure, mature, even-aged stands. In Maine, therefore, logging was selective, leaving the forest intact for later logging of other species as they became commercially valuable, as did a good deal of pine that was left in the first logging because it was small or scattered. In Michigan, on the other hand, clear cutting practically wiped out the pine forests in a generation. Michigan, which at its peak in 1889 cut more than eleven times as much pine as Maine, has produced annually for the past 30 years only about two-thirds as much. Commercial logging in Maine started about two centuries sooner than in Michigan (Chapt. XI); yet its total cut did not reach its peak until 1909. Including pulpwood with lumber, the cut of the two states is now about equal. The bulk of present-day Michigan cut comes from hardwood forests; whereas the bulk of that of Maine is softwood from areas that have been repeatedly logged selectively, chiefly in recent years for spruce and balsam pulpwood. There remains much submarginal hardwood in the northern part of Maine because the only method of transportation is river driving and it will not float. If railroads or highways should penetrate the region, it would probably be merchantable.

It is evident that Maine, in the long run, has profited by all-aged and mixed-specied forests which had to be logged selectively as compared with forests in Michigan, where both economic and forest conditions favored clear cutting.

There was a basic similarity between the generally even-aged pine forests of Georgia and Louisiana; yet, because of economic factors, the

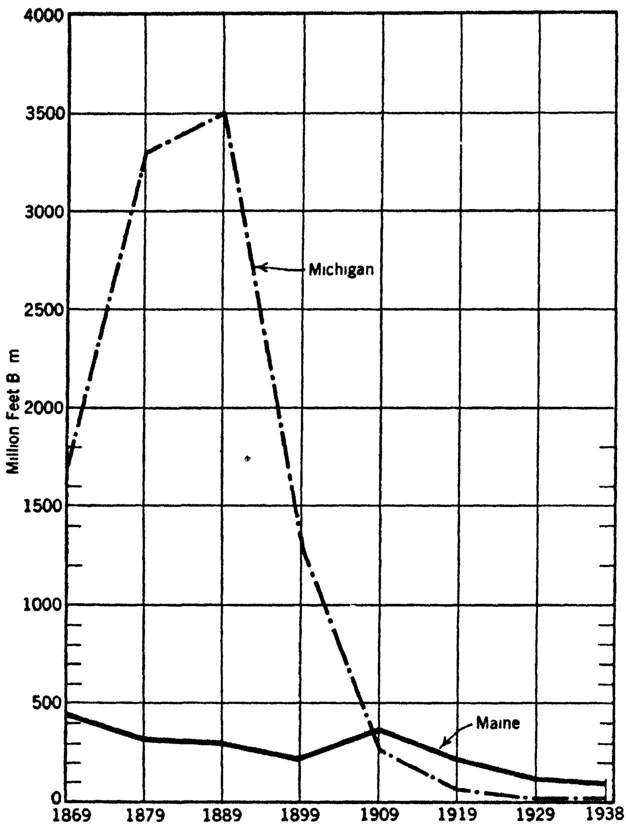

FIG. 29. Comparative cuts of white pine in Maine and Michigan, by decades. [From United States Bureau of the Census.] (See p. 205.)

course and result of their exploitation has been quite different, as is evidenced by Fig. 30 which shows their respective total cuts from 1850 to 1870 and thereafter from pine only. Up to the Civil War both states had small local and export trade of about the same volume, but southern pine, at that time, could not sell in the northern market in competition with white pine. Soon after the war, Georgia was able to send its product northward by water, selling it as a marginal species

on a low-price basis. It was not until about 1890 that the growing scarcity of white pine made it possible for Louisiana to send rail shipments up the Mississippi valley, after which its cut increased rapidly.

Georgia reached its peak production in 1899;[1] Louisiana, not until 1913, but then it was five times that of Georgia. A few years thereafter Louisiana production began to coast very precipitously, but Georgia fell off far less and at least three times since then it has nearly reached its 1899 figure. Since 1929 both cuts have been of the

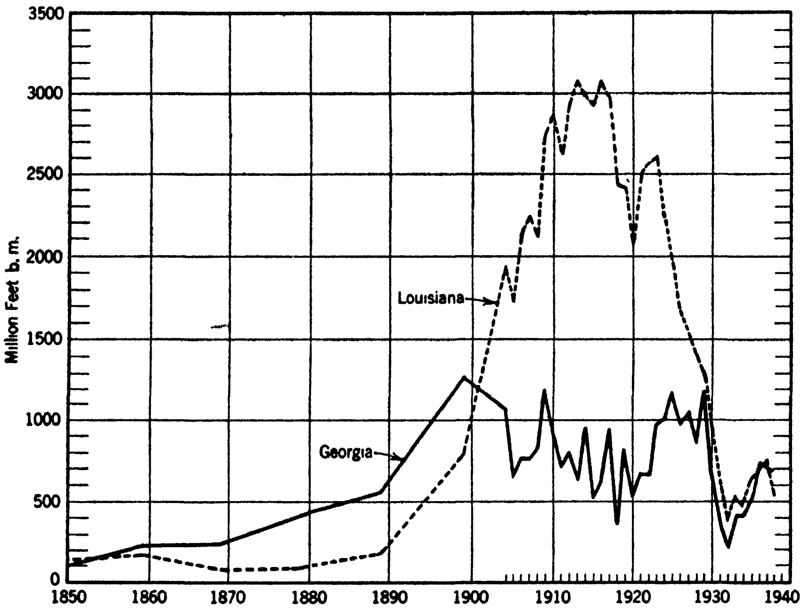

FIG. 30. Comparative cuts of yellow pine in Georgia and Louisiana (1858–1938).

same general magnitude, and in the last few years Georgia has twice produced slightly more than Louisiana.[2]

This can be ascribed to the fact that during the big logging days in Georgia cuttings were to high diameters; hence a good deal of standing pine was left on logged-over areas. In whole sections, notably the Piedmont, timber was abundant but too scattered to attract large

[1] Georgia's production doubtless would have been greater at that time but for the destructive methods of turpentining, which destroyed much saw timber. Later more conservative exploitation in Louisiana was far less destructive.

[2] The value per thousand feet board measure at the mill in Georgia in 1938 was $15.14 and in Louisiana it was $22.57 (United States Census figures), due to the fact that Louisiana's cut is still largely from virgin stands while that of Georgia is from second-growth and cull stands.

operators. In consequence, enough was left to keep up a respectable cut for the small portable sawmills which, even in the days of its much greater importance as a lumber state, were always abundant. By the time Louisiana was opened up in a big way, southern pine was no longer a marginal species and wealthy operators from the north entered the state, purchased great tracts of stumpage, erected huge mills, installed logging railways, and introduced power logging; all this meant the speedy liquidation of Louisiana's pine resources and has left large clear-cut areas which are not restocking. In 1936 Georgia was estimated to have about twice the volume and net annual increment in its pine forests as Louisiana.[1] Probably in the immediate future the production of Georgia will increase but that of Louisiana will decline further.

7. ECONOMICS OF FOREST EXPLOITATION UNDER FORESTRY PRACTICES

The economic factors affecting the exploitation of forests apply equally to those produced by man and to those grown by nature. Nothing in the origin of a forest influences freight, wage, or interest rates. If, at a given time and place, 10-in. oaks of a certain quality are submarginal, they are as much so whether the acorns were planted by men or by squirrels. However, when forestry is practiced, modification of marginal standards set by economic factors is usually necessary in order to provide for later harvests.

Except where clear cutting and planting are intended, where sprout reproduction is expected, or where the area cut is small and will seed in from surrounding trees, either a considerable number of younger and smaller trees must be left to increase in size and thus provide a later cut or a smaller number of larger ones must be left as seed trees to produce an entirely new stand.

Therefore, when logging is conducted as a harvesting operation, it is concerned with two margins, the ordinary immediate profit or *economic margin,* hitherto discussed, and the *forestry margin,* now to occupy our attention. *The forestry margin represents the minimum in size, quality, and number of trees which must be left at the time of logging to insure a later harvest.* The necessary extra cost incurred

[1] I. F. Eldredge, "The Timber Wealth of the Lower South," *The Southern Lumberman,* Vol. 157, No. 1895, p. 115, Dec. 15, 1938. As this comparison unfortunately cannot be made on an acreage basis, the fact that Louisiana is the smaller state has some (but an unknown) influence.

in leaving and protecting them represents a loss of immediate profit and an investment for future stumpage.

As a simple illustration of the relation between the two margins, assume a stand of a single species with diameters ranging from 4 to 24 in., the bulk of the stand being in trees from 18 to 22 in., and those under 8 in. few and scattered. The economic margin is, let us say, 6 in. d.b.h. Ordinarily, logging would be practically a clear cutting, but to insure regeneration it would be necessary to leave a certain number of seed trees of larger diameters. The smallest number, size, and quality of such trees, adequate to accomplish this, would be the minimum forestry margin.

On the other hand, assume that the bulk of this stand is composed of trees under 20 in. While the economic margin would not be changed, the number of submarginal, marginal, and near-marginal trees would be greatly increased and the amount of material that could be obtained from a clear cutting would be much smaller. Leaving a certain number of the smaller sound trees above marginal limits, say those less than 10 in., to add to those below the margin, would increase the amount of material left, sufficient for it to form the basis of a second cut in 20 years; whereas, in the first case it would require a minimum of 60 years before another cut could be obtained.

A forestry margin, therefore, may be based on heavy cuts with a long interval or on light cuts with a short period between them, depending on economic factors and on silvicultural considerations. In even-aged, mature forests where practically all trees are well above the economic margin, it is considered better silviculture to clear-cut, letting the forestry margin consist of seed trees.[1] In younger or uneven-aged stands, partial cutting with intent to return for a second cut in a few years usually is considered silviculturally preferable. In stands between these extremes either system may be practical.

What about the economic aspects? With certain qualifications, the heavier the cut, the greater the immediate profit and the smaller the investment for future stumpage, but the longer the investment must run with its concomitant carrying charges. The lighter the cut, the less the immediate profit, and the greater the investment in future stumpage, but the sooner it can be realized (Chapts. XIV, XV, and XVIII).

Occasionally conditions arise where the economic and forestry margins approach closely. This is likely to occur when economic conditions dictate cutting only to large diameters and, therefore, neces-

[1] Or by making use of artificial reproduction.

sitate leaving considerable material as a basis for later cuts. In Section 6 it was shown that in the early days of the lumber industry in this country, the marginal tree was of large size, good quality, and of a high-grade species. In the absence of fire, many forests so logged recovered and produced a second or even a third crop from the formerly submarginal material without any effort on the part of their owners or of anyone else. Chapman[1] has called this *accidental* or *involuntary forestry.* More or less successful examples in Maine and Georgia were noted in Section 6. Unfortunately it happens more frequently that nature triumphs over economics and the worked-over stands remain submarginal. Economics can win only by staging a boom that will raise demand and prices sufficiently to make their logging worth while.

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[1] H. H. Chapman, *Forest Management,* p. 59, J. B. Lyons and Company, Albany, New York, 1931.

CHAPTER XI

ECONOMIC HISTORY OF AMERICAN FOREST INDUSTRIES

The five stages of the history of the American forest industries, corresponding to those for raw materials in general, discussed in Chapter X, Section 1, occur chronologically as follows:

Stage 1: Colonial stage; from the first settlements to 1790.
Stage 2: Northeastern stage; from 1790 to 1865.
Stage 3: Lake States and southern stage; from 1865 to the first World War.
Stage 4: Pacific stage; from period of the first World War to the present.
Stage 5: The future.

The names given them indicate the regions supplying the major part of the production at the time, but they apply to the country and the industries as a whole. Different industries frequently have been in different stages at the same time, as have different parts of the country. The dates are approximate. The transition between stages has usually required ten to fifteen years. Since the lumber industry is the most important of forest industries, we are chiefly concerned with it and will attempt to portray it against the general economic background of the country as a whole, rather than as an isolated phenomenon. References to conservation activities are introduced to show how clearly they have been related to raw-material shortages and connected with the economic and political thinking of the various periods.

1. THE COLONIAL STAGE

The impact of early settlement on the American forests and their molding effect on American character have often been described and need not be repeated, devastating as was the first and important as was the second; the relationship of the forest to colonial economy is our concern.

The colonies were on their own and received little besides land grants from the home government, which regarded them chiefly as a financial investment. Their first job was to establish themselves on a self-sustaining basis. This meant growing their own food. The forest

was an obstacle, but it provided exportable products in the form of furs and timber, with which to pay for things they could not produce. Europe was avid for furs. They were an ideal export, valuable, not bulky, and to be had for the taking. The colonists took them almost to the point of extermination. England already was importing timber from the Baltic and welcomed the high-grade oak for casks, the white pine for masts and spars, and naval stores from America.[1] Salt fish was at this time a staple food in Europe, and, since fish abounded in the coastal waters, they too became a valuable exchange product to the struggling settlers. The forests provided the materials for the ships in which to catch them. Soon the ships themselves became articles of export.

The utmost demands of the oversea market could not take all the timber products of the colonies; so sales were regarded simply as a good thing when possible—a side issue to the main job of clearing land for crops (a viewpoint which lasted for about two hundred years)—and far more timber went up in smoke than through the crude water-power sawmills which were an early feature of all settlements. Local authorities gave franchises to erect mills and to cut timber on common land (Chapt. XX, Sec. 2*A*) and often set the prices mills could charge for the products. Because of transportation difficulties, the mills moved frequently to be near their source of supply. They were the ancestors of the portable sawmill of today. After the settlements moved back from the coast and navigable rivers, they cut for local use only.

The rapid expansion of agriculture wherever it was possible and the utter lack of roads early resulted in wood scarcities—even for firewood—in the neighborhood of all the settlements. Therefore, conservation regulations in the form of restrictions on cutting and woods burning appeared soon after each colony was established, only to be forgotten, if they were ever observed, as transportation to the ever-receding backwoods opened up; the number of draft animals increased, and the population developed ideas not compatible with public regulation of private activities on the European pattern (Chapt. XX, Sec. 2*A*).

A regularly organized export industry early grew up along the deeply indented coast of Maine, where water transportation facilitated shipments, and, owing to sterile soil and a harsh climate, the forests were not destroyed to make farms. On the southern coastal plains,

[1] All these products were far more important in the seventeenth and eighteenth centuries than in the nineteenth and twentieth.

where natural conditions as to soil and navigable water were somewhat similar, the export of naval stores was the principal source of livelihood. The poor quality of the soil in both regions ever since has tended to perpetuate their forest economy (Chapt. X, Sec. 6).

Local shortages also appear to have caused the introduction of forest products grades and standards. The thrifty merchants at the ports did not intend to lose their trade because a cargo of staves was dozy or because one of the masts was crooked and knotty. Out of these early trade standards have grown the modern grading rules without which the present forest products industries could not function.

The mother country, too, took a hand in the forest situation in the colonies, but her interest was financial and military. The trade and navigation laws expressed her financial interest by forbidding export to foreign countries and their possessions, so that she might herself make a profit on re-export. The "broad-arrow" [1] laws were designed to insure a supply of masts and ship timber for the royal navy,[2] then busily engaged with the French, Dutch, and Spanish fleets, in determining the mastery of the seas, a contest in which the colonists had a hand and a stake, for its outcome in part determined their future. In any event, they honored the broad arrow as they had the trade and navigation laws—in the breach rather than the observance—cut the king's trees when and where they found them, and, evading customs regulations, sold to all who would buy, including the Frenchman and the Spaniard. Nevertheless, ill feeling, due to these restrictions, was one of the causes of the American Revolution.

One thing that facilitated both agriculture and lumbering was that land passed quickly into individual private ownership. Ironically enough, this was no part of the intention of the founders of the colonies, who, except in New England, hoped by the carefully controlled sale of lands, to make fortunes. However, the need for settlers and the exigencies of those who found themselves in the midst of an expanding economy and demanded a stake in it, burst the bounds of the intended system and laid the groundwork for the United States public land system with all its virtues and failings.

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[1] Trees reserved for the royal navy were marked with the king's arrow, still used in Britain to indicate government property.

[2] The measures were conservation ones on the timber-reserve principle (Chapt. XX, Sec. 4*B*). The difficulties experienced by the British in obtaining materials for building and repairing the wooden walls of England are discussed by R. H. Albion, *Forests and Sea Power: The Timber Problem of the Royal Navy, 1652–1862*, Harvard University Press, Cambridge, 1926.

The close of the colonial period ended the first stage of the American lumber industry. Before examining the second period, it is interesting to notice how differently forests were exploited in Canada, owing largely to different objectives and character of its settlement. The French settlements were organized by the government because of the fur trade which was a government or quasi-government monopoly. There was no intention of building up a self-sustaining agricultural economy, and settlers were few. Under one of the most magnificent strategic conceptions in history France seized control of the St. Lawrence valley, the Great Lakes, and the Mississippi and prepared to dominate a continent. Only when Canada passed to England and the Mississippi valley to the United States did the axe of the settler and the lumberman drive out both the trapper and his prey and set up a less romantic economy.

2. THE NORTHEASTERN STAGE

This stage, ushered in with the establishment of the new nation and lasting to the end of the Civil War, took place during a period of great expansion, when the rapidly increasing population, moving across the Alleghanies, flowed into the vast area of public domain to the west and began to enjoy enormous prosperity through the exploitation of its virgin land on a scale hitherto impossible. The lumber industry helped to create and shared this prosperity to an extent which it could not have done without great technological change (Chapt. XII, Sec. 5).

The development of river driving and log rafting enabled the industry to move back from coastal waters far into the interior, well in advance of settlement. Increased size of mills and enlarged capacity, due to the invention of the circular saw, meant larger output. Later, steam gave greater power and more flexibility in mill location. Local shortages could now be made good by transportation from other regions, and stumpage was cheap and abundant from state and later from federal public lands. Large tracts could be bought for next to nothing. In 1792, 3,934,899 acres of public land in central New York sold for eight pence, or about $0.16 an acre. The following year the state of Massachusetts sold 2,107,396 acres at $0.125 an acre in what is now the state of Maine. A double profit commonly was made on land that was cleared of its timber and then sold for agricultural settlement. Early in the period this profit was often larger than the stumpage-conversion profit.

It is not surprising that everyone believed our forests were inexhaustible and that the only conservation legislation was to protect a

single species of high value, growing in a restricted region. The naval timber reserves of live oak, established by the federal government, curiously resembled in policy, practice, popularity, and effect, a broad arrow redrafted to form a U. S. (Chapt. XX, Sec. 4*A*).

Canadian competition and British Empire trade policies diminished the importance of the export trade, which has been of minor importance ever since; but, as cutting moved up the great rivers of Maine far into the interior, the domestic market expanded so fast that this falling off of foreign markets was scarcely noticed. A little later, operations moved up the Hudson, the Delaware, and the Susquehanna. Later still they jumped to the headwaters of the Ohio and to southern Michigan to supply the detached market opening up in the Mississippi valley. Throughout the period shipment by water dominated, although the railroads began to carry lumber into the prairie states before the period ended.

Except for the naval stores industry, the southern forests were not heavily exploited although local and export operations to the West Indies continued as in colonial days. Southern population increased more slowly than northern. Its capital was busy developing a cotton economy based on slave labor. The forests of the cotton belt were slaughtered by fire and axe after the colonial pattern as plantations grew in number and acreage.

Lumbering began in the Pacific Northwest at the time of the gold rush, along the tidewaters of Puget Sound, which started shipping to California. Here men were too pre-occupied with mining to exploit its somewhat inaccessible mountain timber. A small Pacific export trade grew up, but it was nearly fifty years before products from this region entered the eastern market. A small pioneer industry also started on the eastern fringes of the Rocky Mountains to supply the needs of local mining, but like that of the Pacific Northwest it functioned outside the growing national industry of the East.

As the period drew to a close, the industry was beginning its second great shift; the Northeast, although still in full production and the most important region, was no longer able to supply a market that was expanding both in demand and territory,[1] and the invasion of the Lake States had begun in earnest. Owing to cheap stumpage and the many small mills, the industry usually was owned and operated by one man or by a simple partnership and was financed largely on commercial credit that was advanced by wholesalers in the market into which its products were fed. It was prepared to move from

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[1] Figure 32 shows the distribution of national cut by decades.

region to region as stumps, if not farms, replaced standing timber. The time of large consolidations, heavy capitalization, and intense interregional competition, with thoughts of scarcity, lessened demand, and ghost towns, was still in the future.

3. THE LAKE STATES AND SOUTHERN STAGE

This stage lasted from the close of the Civil War to the time of the first World War. It marked the culmination of lumber production, the origin and rapid rise of our second most important forest industry, pulp and paper manufacturing, and its later years saw the real beginnings of forestry because the public began to feel that forests might not last forever. As the period opened, production centers were shifting from the Northeast to the Lake States and adjacent portions of Canada, giving rise to a tariff war (Chapt. XVII, Sec. 12). By the middle of the period, the southern forests were being drawn upon heavily (Chapt. X, Sec. 6), and production in the Northeast, the Lake, and the Central regions had shrunk to relative unimportance. At the end of the period the local manufacturers in the West, particularly in the Northwest, had entered the eastern market and a lumber industry was functioning on a national scale, with its chief supply sources far from major consuming centers.

Following characteristic patterns of the times, the industry expanded its facilities, increased its investment in raw materials, indulged in consolidations and in intense competition, and was at the same time accused by the people of monopoly of raw materials and of price fixing.[1] Generally it showed little interest in forestry, deeming it impractical or smacking of government interference with private business, but the industry did see great possibilities of gain from large reserves of stumpage.

Trade associations grew up on a local, regional, and national basis, sometimes competitive as when Lake States associations tried to edge southern pine out of a market, sometimes cooperative as when they worked together to stabilize prices. They were organized by manu-

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[1] See *The Lumber Industry*, United States Department of Commerce and Labor, Washington, D. C., 1914.

Although the government was able to prove large concentration of holdings of virgin timber in a few hands on the Pacific Coast, in the South, and in the Lake States, whether or not they constituted an effective monopoly is questionable (Chapt. VIII, Sec. 3*H*). Suits against various companies and trade associations were instituted by the government on charges of price fixing; in some cases convictions were obtained. See R. C. Bryant, *Lumber*, pp. 327–345, 2d edition, John Wiley and Sons, New York, 1938.

facturers, wholesalers, and retailers to serve the interests of each.[1]

Technological improvements, such as the introduction of the band saw and automatic mill machinery, reduced labor costs and increased output. In the woods, the use of logging railroads made year-round logging possible, tapped land too far from streams for river driving, and thus also solved the problem of bringing out hardwood logs which will not float when green. Power machinery in the woods, such as log loaders and skidders, speeded up and cheapened the process of getting timber out of the woods to the logging spur.

All this required large outlays of capital, which was justified only by the control of large bodies of stumpage, and it became necessary to secure several years' advance supply. At first this was not difficult or expensive. Government land in the Lake States sold for $2.50 per acre, which, with the higher price of lumber and the greater yield per acre, made stumpage very cheap. Nor were some operators above stealing it from federal- or state-owned land adjacent to their holdings, which at that time was indifferently patrolled.

The cry of timber famine aroused far-sighted and disinterested individuals outside the industry, who after twenty years of agitation began to succeed, and in 1891 the first public forests were established (Chapt. XX, Sec. 2*B*).

Soon after 1900 it became evident that the supply of virgin timber would not last forever, and even greater price rises than had taken place in the past were expected (Chapt. XII, Sec. 3). A scramble to secure stumpage ensued. As speculators took a hand in the game, companies with large investment in mills and machinery bought large tracts of land at prices driven up by their own eagerness. No longer was a 5- or 10-year supply considered ample; it had to be from 20 to 40 years. The much greater required outlays called for different methods of financing. Early in the period corporations had replaced partnerships or one-man ownership, and short-term borrowing had given way to long-term. Among the new devices for securing capital were timber bonds (Chapt. III, Sec. 4*C*). These bonds, based on the assumption of rising demands and prices, were a useful financial device at first but, when demand declined, later became a heavy burden on the industry. Stumpage prices continued to rise, and it was no longer easy to sell cutover land to homesteaders and thus recover part of its cost. At the end of the period the industry was geared to increasing production, but the market was declining so that it began to

[1] Bryant, *op. cit.*, p. 299.

show the effect of overproduction and overcapitalization, destined to plague it in succeeding years.

4. THE PACIFIC STAGE

At the close of the first World War the lumber industry had passed its peak of production, but it still exhibited all the characteristics of a period of expansion. It now had to face the problems of a declining market, with a heavy load of overcapitalization. The reasons for the market decline are discussed in Chapter XII, Sections 2 and 5. The overcapitalization grew out of the optimism and miscalculations of the latter part of the preceding period.

Within the forest industries themselves, there was a change in emphasis. While the use of lumber was giving place to other structural materials, the demand for pulp and paper products was rising rapidly as new uses continued to be found for them. The first World War disrupted the rather small American export lumber trade [1] and, at its close, depressed economic conditions in Europe caused it to decline still more. The center of production had shifted to the Pacific Northwest, but the expected exhaustion of the southern region did not occur (Chapt. XII, Sec. 3) and competition from the South was violent, even though use of the Panama Canal made delivery of Pacific Coast lumber to the Atlantic seaboard possible on a large scale.

The depression of 1929 affected the lumber industries even more than most of the other great ones. The National Industrial Recovery Act, with its joint effort to introduce forestry and price stabilization by cooperation between government and industry, did not last long enough to show what it might have done.[2] Improved economic conditions have helped somewhat and the defense and war boom more, but the fundamental conditions have not been changed.

The forestry movement has continued actively, chiefly along the lines of public endeavor, but it has not been able to do enough to rectify the basicly unsound conditions of the major forest industry. However, the pulp and paper industry, after running through its own cycle of overexpansion at the close of the first World War, chiefly in its newsprint division,[3] gives serious evidence of adjusting its supply

[1] Bryant, *op. cit.*, p. 415.

[2] Franklin Reed, "The National Lumber Code," *Journal of Forestry*, Vol. XXXI, No. 6, p. 644, October, 1933; also the articles by C. W. Baler and J. B. Woods, Vol. XXXIII, No. 3, March, 1935.

[3] J. A. Guthrie, *The Newsprint Industry*, Chapt. V, Harvard University Press, 1941.

problems on a continuing basis, by making use of forestry practices.

Taking the country as a whole, it is still in Stage 4, which was called in Chapter X, Section 1, the late industrial stage. Dealing exclusively with the forests, it might better be called the late *extractive* stage. Its national close will come when the remaining important bodies of virgin timber are exhausted and the industries have to depend upon forestry grown or volunteer timber; turn to imports, or go out of business. This will probably be twenty-five to fifty years hence. The future is discussed in Chapter XII. It is not history.

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CHAPTER XII

DEMAND FOR FOREST PRODUCTS IN RELATION TO THE PRACTICE OF FORESTRY

The future of forestry, in the sense of producing wood or wood-derivative products, whether as a public or a private venture, depends in large measure upon the extent and nature of the future demand for such products. It is the purpose of this chapter to explore this question. Admittedly, no precise answer is possible, but it is possible at least to determine what factors have influenced demand in the past and to investigate their possible operation in the future.

In such an inquiry, we must realize that forest products cannot be treated as a whole. Wood as a raw material is not a uniform product. Different species, or even the same species, may produce different products, used for different purposes, manufactured by different processes, and sold in different markets, frequently influenced by dissimilar or even opposing tendencies. Plywood is a substitute for lumber as an interior finish but is, nevertheless, itself a wood product, perhaps best considered as lumber in another form. Douglas fir competes with yellow pine for building construction, on a price basis, but neither is a substitute for white oak, walnut, and cherry in the luxury furniture trade. All are in competition with other products, but in different ways. All are affected by variations in business conditions, but not necessarily equally. Spruce, used largely for pulp products which are consumers' goods, bought at frequent intervals by individuals in small quantities, is less affected by economic depressions than lumber which is used largely for durable or for producers' goods and therefore is bought even by ultimate consumers in fairly large quantities at one time but these times are infrequent. The progress of invention works faster in some fields than in others; substitutes reasonably satisfactory, or better than wood, may be found for some of its uses. Invention in the future may produce entirely new uses.

Any full inquiry into the future uses of forest products must consider all this and much more, as must an individual owning a forest where nature always sets limits to what he can produce. In a general work all that can be attempted is a discussion of the most important

wood uses, and those solely in broad terms, leaving special problems of variation in species and products and regions for detailed studies.

1. DEMAND, PAST AND PRESENT [1]

A. All Products. Statistics on total consumption [2] of forest products have not been systematically collected over long periods, but the United States Forest Service has estimated it for certain years and periods, reducing all products except wood-derivative ones, such as naval stores, collected without felling the trees, to thousands of cubic feet. These estimates are

1907	23,237,600 [3]	1925–1929	14,495,308 (Average for 5-year period) [5]
1920	24,318,915 [4]	1936	11,400,007 [5]

It is evident that the trend is downward. In 1936 consumption was less than 50 percent of its highest figure although there has been some increase since then.

Table 13 breaks down the 1936 figures and the 1925–to–1929 averages into types of uses. It will be noted from Columns 3 and 5 that lumber and fuelwood are the largest items, lumber comprising about half the value of production and fuelwood nearly one-third. Although fuelwood is the second largest use in terms of volume, being more than half that of lumber, obviously it is of far less proportionate value. Pulpwood, which was fourth in terms of volume in 1925–1929, became third in 1936 and may be considered the second most important forest product even though on a volume basis its production was only about 8 percent as much as lumber in the 1925–1929 average and about 13 percent in 1936.

The percentage changes in distribution between the two periods show no major shifts in usage, but the figures in Columns 6 and 7 indicate that, in the face of a 20 percent decline in total production, pulp and veneer logs increased by significant amounts and the per-

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[1] For background reference, see Raphael Zon, "Trends in World Wood Consumption," pp. 279–297, Copeland Report, 1933.

[2] Strictly, the terms demand, consumption and production are not the same, nor are they in adjustment for short periods. When long-range tendencies are dealt with, they may be considered synonymous.

[3] R. S. Kellogg, *Timber Supply of the United States,* United States Forest Service Circular 166, 1909.

[4] 1920 Report on Senate Resolution 311, *Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership.* Prepared by the United States Forest Service, and hereafter referred to as the *Capper Report.*

[5] Table 13, Column 4.

centage of decline in lumber output was less than in several other items.

B. Lumber. Until the first decade of the twentieth century, the rise in lumber production was continuous and generally at an increasing rate from decade to decade. According to the Forest Service estimates, lumber production culminated in 1906 with a total of slightly

TABLE 13

CONSUMPTION OF FOREST PRODUCTS IN THE UNITED STATES, AVERAGE OF 1925–1929 COMPARED WITH 1936 [1]

In Billions of Cubic Feet (Ciphers Omitted)

(1) Product	(2) 1925–1929 Average Volume [1]	(3) % of Total	(4) 1936 Volume [1]	(5) % of Total	(6) 1936 Increase or Decrease	(7) % of Change
Lumber	7,371,372	50.8	5,367,585	47.1	2,003,787(−)	27.1(−)
Fuelwood	4,002,635	27.6	3,619,482	31.7	383,153(−)	9.5(−)
Pulpwood	588,666	4.1	705,924	6.2	117,258(+)	16.6(+)
Hewed ties	633,034	4.4	354,189	3.1	278,845(−)	44.0(−)
Fence posts	628,836	4.3	327,060	2.9	301,776(−)	47.9(−)
Veneer logs	230,607	1.6	252,443	2.2	21,836(+)	8.7(+)
Mine timbers	231,780	1.6	161,016	1.4	70,764(−)	30.6(−)
Cooperage stock	302,699	2.1	149,447	1.3	153,252(−)	50.6(−)
Shingles	138,558	1.0	108,658	1.0	29,900(−)	21.5(−)
All others	367,121	2.5	354,203	3.1	12,918(−)	3.5(−)
Total	14,495,308	100.0	11,400,007	100.0	3,095,301(−)	21.3(−)

1 1925–1929 average from p. 214, Vol. I, Copeland Report; 1936 figures, United States Forest Service Statistics 241 FC 37.

over 46 billion ft. b.m.; it has since declined irregularly. An annual cut exceeding 25 billion ft. b.m. has been considered high in recent years, although wartime demands may surpass it.

Table 14 gives the total annual cut for both hard and softwood for the last forty years, both in figures and in index form (Chapt. VIII, Sec. 3*C*), based on the 1899 cut of approximately 25 billion ft. b.m. The index figures facilitate study of the rate of change and show the much greater decline in hardwood production (nearly 60 points as against about 30 points). Figure 31 is a graph of these index figures for all lumber, bringing out the annual variations in cut. Its highest figure is 131.4 in 1906; its lowest, 28.9 in 1932—a maximum spread

TABLE 14

Lumber and Pulpwood Production in the United States, 1899–1939

Lumber in Billions of Feet Board Measure; Pulpwood in Millions of Cords

Year	All Lumber [1]	Index [2]	Softwood Lumber [1]	Index [2]	Hardwood Lumber [1]	Index [2]	Pulpwood [3]	Index [2]
1899	35.078	100.0	26.180	100.0	8.898	100.0	1.617	100.0
1904	34.135	97.3	27.353	104.4	6.782	76.2	2.477	153.2
1905	30.503	86.9	24.915	95.1	5.588	62.8	2.547	157.5
1906	46.000	131.4	34.900	133.3	11.100	124.7	2.922	180.7
1907	40.256	114.8	31.001	118.4	9.255	104.0	3.037	187.8
1908	33.224	94.7	25.546	97.5	7.678	86.2	2.652	164.0
1909	44.510	126.8	33.897	129.4	10.613	119.2	3.208	198.4
1910	40.018	114.1	31.160	119.0	8.857	99.6	3.147	194.6
1911	37.003	105.4	28.902	110.3	8.101	91.0	3.390	209.6
1912	39.158	111.6	30.526	116.6	8.632	97.0		
1913	44.000	125.4	34.065	130.1	9.935	111.6		
1914	37.346	106.4	29.407	112.3	7.939	89.2	3.641	225.1
1915	37.012	105.5	29.485	112.6	7.527	84.5		
1916	39.807	113.5	31.332	119.7	8.475	95.1	4.445	274.8
1917	35.831	102.1	29.174	111.0	6.657	74.8	4.706	291.0
1918	31.890	90.9	25.667	98.0	6.223	69.9	4.506	278.6
1919	34.552	98.5	27.407	104.6	7.145	80.2	4.446	274.9
1920	35.000	99.8	27.610	105.5	7.390	83.0	5.015	310.1
1921	29.000	82.6	23.444	89.5	5.556	62.4	3.740	231.2
1922	35.250	100.5	28.922	110.4	6.328	71.1	4.499	278.2
1923	41.000	116.9	33.220	126.8	7.780	87.4	4.637	286.7
1924	39.500	112.6	31.549	120.4	7.951	89.3	4.720	291.8
1925	41.000	116.9	33.284	127.1	7.716	86.7	5.005	309.5
1926	39.750	113.3	32.078	122.5	7.672	86.2	5.490	339.5
1927	37.250	106.1	29.975	114.4	7.275	81.7	5.527	341.8
1928	36.750	104.7	29.852	114.0	6.898	77.5	5.795	358.4
1929	36.886	105.1	29.813	113.8	7.073	79.5	6.412	396.5
1930	26.051	74.3	21.323	81.4	4.728	53.1	6.099	377.2
1931	16.523	47.1	13.852	52.9	2.671	30.0	5.985	370.1
1932	10.151	28.9	8.746	33.4	1.405	15.7	4.891	300.3
1933	13.961	39.7	11.899	45.4	2.062	23.1	5.964	368.8
1934	15.494	44.2	12.736	48.6	2.758	30.9	5.980	369.8
1935	19.539	55.7	16.248	62.6	3.291	36.9	6.591	407.6
1936	24.355	69.4	20.242	77.3	4.113	46.2	7.506	464.2
1937	25.997	74.1	21.589	82.4	4.408	49.5	9.348	578.1
1938	21.646	61.1	18.293	69.8	3.353	37.6	8.153	504.2
1939	24.975	71.2	21.242	81.1	3.733	41.9		

1 From United States Forest Service publication, *Lumber Production 1869–1934*, and supplements, 35, 36, 37, and 38. Figures for 1939, from preliminary report on lumber industry, United States Census, issued Dec. 12, 1940. In certain years the Forest Service has raised the census figures to take account of apparent gaps in the latter. Such changes are indicated in the data sources.

2 Index for all lumber figured from 1899 cut of 35.078 billion ft. b.m. = 100.0. Other indices from actual figures for year 1899.

3 Domestic pulpwood only. Figures 1899–1936 from Table 2, p. 60, *United States Pulp and Paper Industry*, 1938. United States Department of Commerce, Trade Promotion Series 182. Those for 1937–1938 Census reports, deducting apparent imports. Figures approximate only.

of 102.5 points. These great variations have been evened off by the use of averages for each decade in Table 15, in which Columns 2 and 3 show that there was no great decline in average annual production till the decade of 1930–1939 when it fell nearly 50 percent. The greatest fall, as might be expected, was in the first half of the decade during the depression. The average cut of all lumber from 1935 through 1939 was 23.302 billion ft. b m. which gives an index figure of 61.8 percent of the average cut of the 1899–1909 decade.

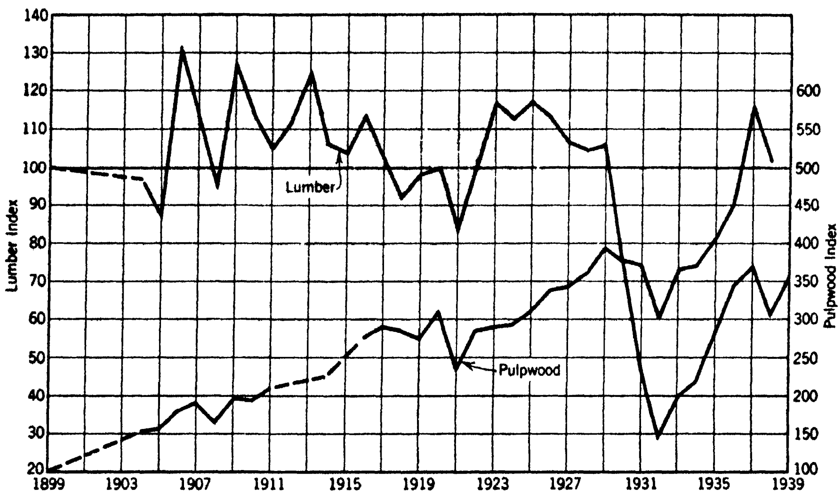

FIG. 31. Indices of lumber and domestic pulpwood production in the United States, 1899–1939 (1899 = 100). *Note differences in scale of the two curves* [Plotted from Table 14, Columns 3 and 5.]

The changes in geographical distribution of cut are illustrated in Fig. 32, which brings out statistically the tremendous shifts that have taken place in major sources of supply, discussed in Chapter XI. The present split of distribution between the southern and the western regions should be remembered along with the fact that, jointly, they dominate the producing field for softwood timber and seem likely to do so for many years to come.

Table 16 gives a percentage breakdown of major uses of lumber for 1929 to 1939. It emphasizes the importance of lumber as building material compared with all its other uses and shows that the percentage of the annual cut going into building and construction has increased in recent years. In 1939 it was some 15 percent higher than in 1929. Figure 33 shows in index form the amount of building lumber used in comparison with all lumber and points out that the amount so used was approximately the same in 1939 as in 1929 even though

lumber production as a whole had fallen about 25 percent. Evidently lumber is still an important building material.

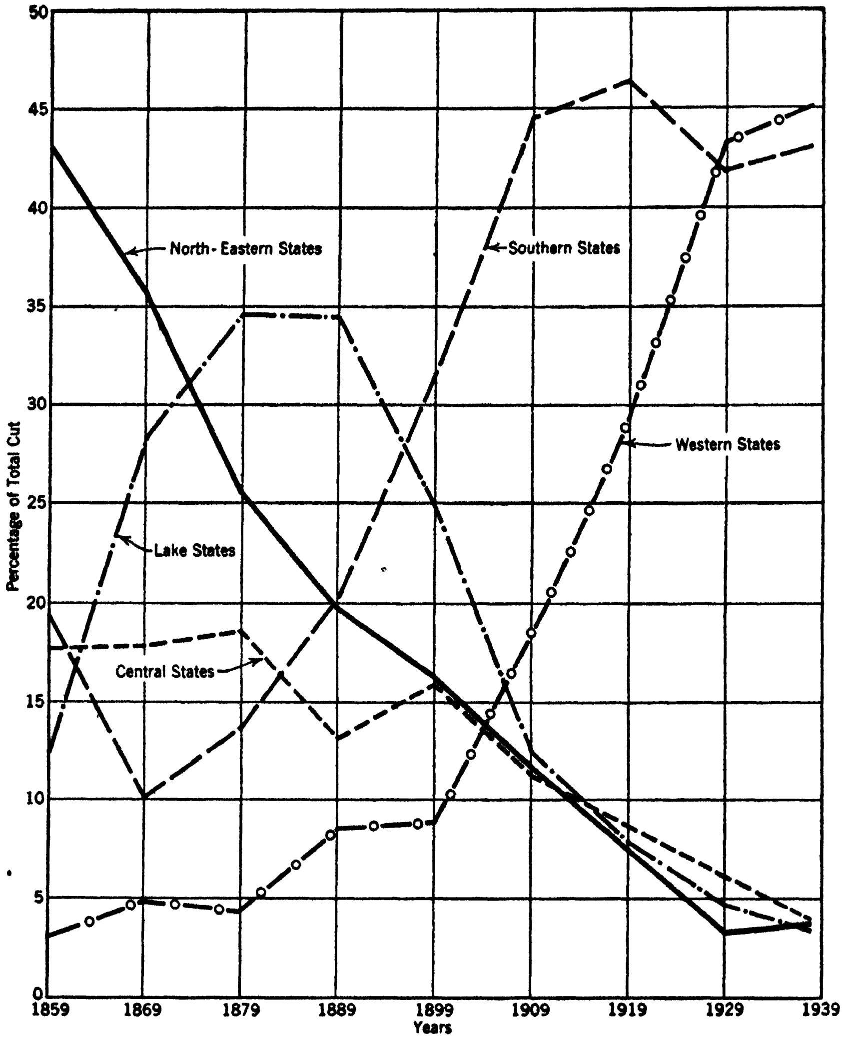

FIG. 32. Percentage to total lumber production obtained from different lumber-producing regions by decades, 1859–1938. [From United States Census figures.]

C. Pulpwood. The commercial use of wood pulp in paper making in the United States began in the late sixties,[1] but statistics of the amount of wood used do not go back further than 1899. Table 14

[1] L. G. Stevenson, *The Background and Economics of American Papermaking*, p. 23, Harper and Brothers, New York, 1940.

gives them for domestic production as well as for a production index on an 1899 base. Figure 31 is a graph of these indices. Since the scales and the quantities involved are not the same in the pulpwood as in the lumber curves, they may be compared only as to trends, their crossing point having no significance. What is significant is the rising trend of pulpwood production as compared with the falling trend

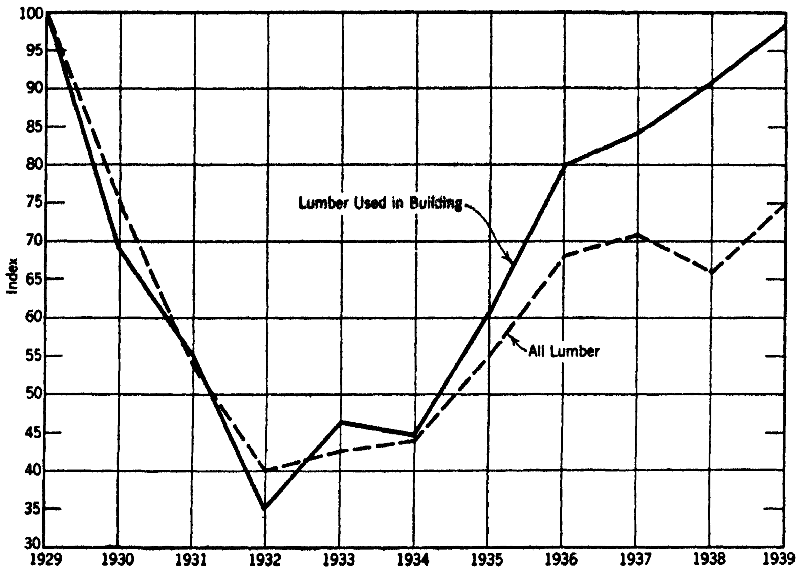

FIG. 33. Index of total lumber consumption in the United States from 1929 to 1939 compared with index of lumber used in building construction (1929 = 100). [From Table 50, *Lumber Facts, 1939,* and its 1940 Supplement, National Lumber Manufacturers Association, Washington, D. C.]

of lumber. In 1937 the lumber production index stood at 74.1; pulpwood, at 578.1. In other words, only about three-fourths as much lumber was produced in 1937 as in 1899 but five times as much pulpwood.

Whereas lumber exports and imports in the United States more or less balance, very little pulpwood is exported and much is imported, the amount varying from a maximum of 23.4 percent of the total consumption in 1906 to a minimum of 9.4 in 1933. The general tendency has been for imports to decline in percentage and amount. The average imports to the time of the present war were about a million cords per annum. The early imports were largely from Canada; later, Scandinavian countries figured as important sources. War conditions in Europe now affect this trade adversely. Inclusion of pulpwood

TABLE 15

AVERAGE LUMBER PRODUCTION BY DECADES, 1900–1939

Billions of Feet, Board Measure

(1) Decade	(2) Average, All Lumber	(3) Index	(4) Index Gain or Loss	(5) Average, Softwood	(6) Index	(7) Index Gain or Loss	(8) Average, Hardwood	(9) Index	(10) Index Gain or Loss
1900–1909	37 661	100.0		29.087	100.0		8.574	100.0	
1910–1919	37.662	100.0+		29.713	102.2	+ 2.2	7.949	92.8	− 7 2
1920–1929	37.138	98.6	− 1.4	29.974	103.0	+ 3.0	7.164	83.6	−16.4
1930–1939	19.869	53.5	−46.5	16.617	57.1	−42.9	3.252	37.9	−62.1

Columns 2, 5, and 8. Calculated from Table 14.
Columns 3, 6, and 9. Use average cut 1899, 1904–1909, as = 100 0.
Columns 4, 7, and 10. Loss or gain figured from 1900–1909 in each case.

TABLE 16

MAJOR USES OF LUMBER BY PERCENTAGES, 1929–1939 [1]

Year	Building and Construction [2]	Boxes and Crating [2]	Industrial [2]	Railroad Construction [2]	Export [2]	Total [3]
1929	52.10	13.08	17.00	9.11	8.71	100.00
1930	47.55	15.24	18.09	10.55	8.57	100.00
1931	52.74	17.61	12.01	8.94	8.70	100.00
1932	50.27	19.67	10.87	10.51	8.68	100.00
1933	55.53	16.83	10.65	8.57	8.42	100.00
1934	52.58	17.21	10.80	10.77	8.64	100.00
1935	59.19	15.17	10.72	8.18	6.74	100.00
1936	62.78	13.52	9.79	8.53	5.38	100.00
1937	62.02	13.10	9.48	9.76	5.64	100.00
1938	69.13	12.65	8.42	5.59	4.21	100.00
1939	68.66	11.78	8.76	6.85	3.95	100.00

1 Lumber Survey Committee reports of United States Department of Commerce as quoted on p. 50, *Lumber Industry Facts*, 1939, and p. 10, 1940 supplement, National Lumber Manufacturers Association, Washington, D. C.

2 *Building and Construction* in preceding table includes all construction except by the railroads. It includes flooring and other planing mill products. Trends are based upon building reports of F. W. Dodge Corporation and Bureau of Labor Statistics. *Boxes and Crating* is based upon carloadings and other indices of merchandise, fruit and vegetable movement. *Industrial* includes car construction and repair, except by the railroads, furniture, automobiles, caskets, shipbuilding, etc., estimated from various industrial reports. *Railroad Construction* includes sawed ties, car construction, and repairs in company shops and the lumber used by the railroads for building, maintenance of way, etc., from Bureau of Railway Economics and *Railway Age*. *Exports* are of boards, sawed timber, and flooring, from Bureau of Foreign and Domestic Commerce.

3 The totals used in figuring these percentages do not entirely agree with the United States Census figures of production for the year, supposedly being based on consumption rather than on production.

imports in Fig. 31 would not change the picture materially. A pulpwood curve that includes imports may be compared with the lumber curve in Fig. 37, where both are rounded and plotted on a logarithmic scale. It is evident, both from an inspection of the index figures (Table 14) and from Fig. 37, that further increases in pulpwood may be expected—that the rate of increase in domestic pulpwood production and total pulpwood consumption is somewhat declining. Although

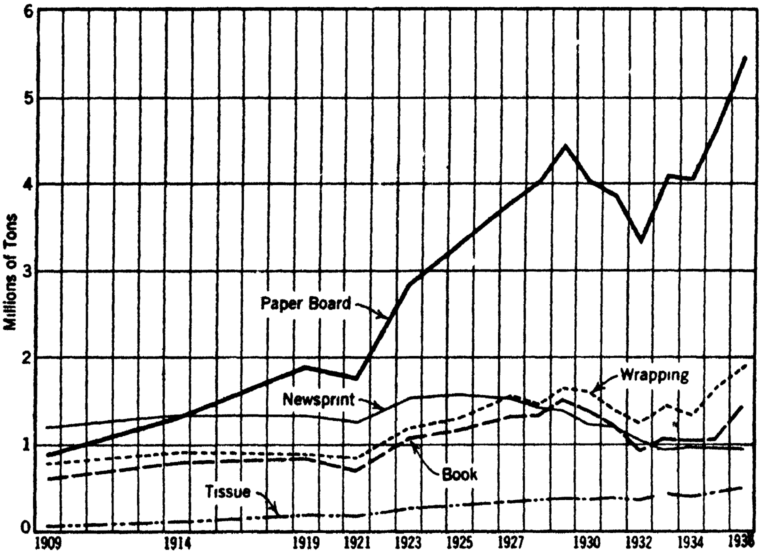

FIG. 34. Production of paper and paper board in the United States, 1909–1936 [From D. J. Studley, *United States Pulp and Paper Industry*, pp. 22, 74–76, United States Department of Commerce, Washington, D. C., 1938.]

further increases seem probable, they will be at a declining rate, accompanied, of course, by ups and downs due to business conditions.

Pulpwood is made into almost as many different products as lumber itself. The kinds of woods necessary for the production of different kinds of paper products do not always grow in the same region. The processes of manufacture of different woods and products likewise differ. Figure 34 deals with types of products; Fig. 35, with species; and Fig. 36, with regional production. The production of paper by major trade classifications is shown in Fig. 34. All products have increased more or less except newsprint, which has declined markedly.[1] The greatest gain has come in paper board, which amounts to about the

[1] For complete discussion of newsprint see J. A. Guthrie, *The Newsprint Paper Industry, An Economic Analysis*, Harvard University Press, Cambridge, Massachusetts, 1941.

same tonnage as all the others combined. The largest item in the breakdown of paper board is container board, from which material grocery and packing cartons are made. This item, of itself, is now the largest single use of paper stock.[1] The curve of paper board shows

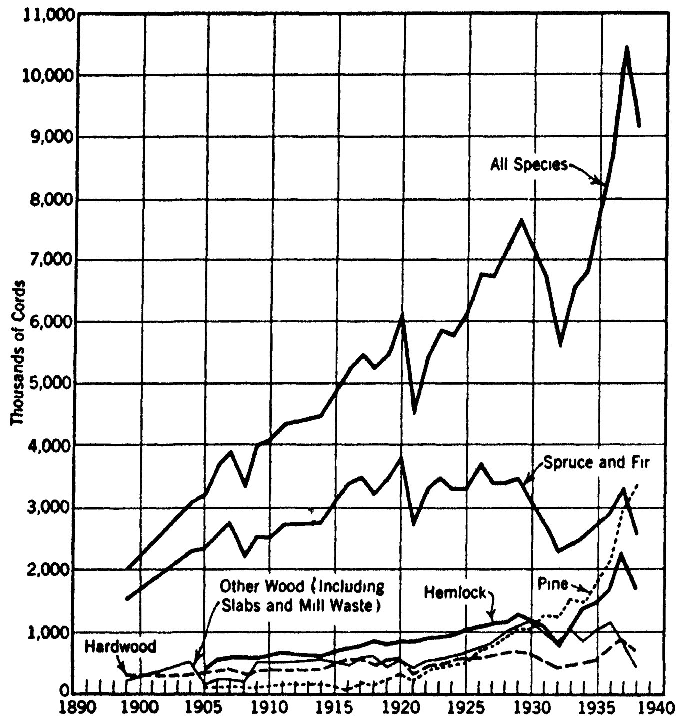

FIG. 35. Distribution of pulpwood consumption in the United States by kinds of wood, 1899–1938. [Courtesy, American Pulp and Paper Association and American Pulpwood Association. From their publication, *Forest Industry and National Forest Economy,* p. 6, 1940.]

little indication of leveling off although the figures for 1938 were slightly below those of 1937.[2]

The increasing use of container board and other types of paper containers is one of the causes of the decline in consumption of boxing and crating lumber (Table 16). Figure 35 shows the distribution of pulpwood consumption in paper mills by major species and by wood

[1] United States Census reports on paper and paper board production, 1937 and 1938.

[2] Paper board production has been expanded even more vastly by wartime demands, but some of the increase comes from reworked stock such as old newspapers.

wastes of various kinds. Spruce and fir, long the standard and most important pulpwoods, have shown a declining trend since 1920 and recently yielded first place to pine, mostly from the South, but they are still ahead of hemlock. The relative unimportance of other woods, including all hardwoods and mill waste, is observable from the dif-

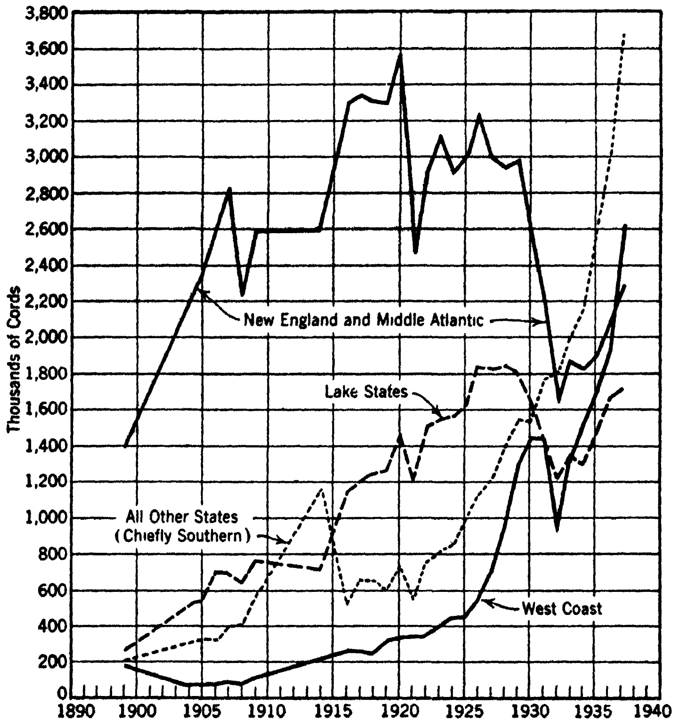

FIG. 36. Regional distribution of pulpwood consumption in the United States, 1899–1938. [Courtesy, American Pulp and Paper Association and American Pulpwood Association, *op. cit.*]

ficulties encountered in reading their curves. The decline in mill waste in the last few years may be a reflection of depressed conditions in the lumber industry.

Figure 36 shows the regional distribution of pulpwood consumption from 1899 to 1938. The decline of the northcentral states and Lake States and the great increases in the southern and western regions have certain analogies to what have occurred in lumber production (Chapt. XI, Sec. 3, and Fig. 32).

D. Plywood and Other Products. Although it is possible to discuss here only the major categories of forest products, the increased con-

sumption of plywood and veneer (Table 13) is worthy of special note. We can understand it best by thinking of them as lumber manufactured by a different method. With veneers, this method of cutting the wood into thin sections shows the fine grain of ornamental wood to best advantage; in plywood, where the bulk of the increase has occurred, the built-up sections of common woods have structural, dimensional, and economic advantages for certain uses not found in common lumber. This increase might have been even larger, had there been large quantities of suitable material in the form of high-grade logs of large dimensions.

E. Causes of Changes in Demand. Changes in demand, resulting sometimes in increased and sometimes in decreased use of different forest products, have been brought about by various interacting factors, such as changes in population, its distribution, and the economic level at which it lives; the shifting sources of supply of products, as reflected in costs to ultimate consumers; the progress of invention, resulting sometimes in development of wood substitutes and sometimes in new wood uses. The latter are termed, along with similar changes in other fields, *technological changes.* All these factors are discussed separately in the following four sections.

2. POPULATION AND CONSUMPTION

Obviously, the larger a population, the more of all essential commodities it may be expected to consume. While no long-term series of per capita consumption figures of forest products is available (Sec. 1*A*), the consumption for lumber increased slowly for the first fifty years of the nineteenth century and thereafter rose with extraordinary rapidity, culminating in 1906 at 523 ft. b.m. It has since declined markedly and in 1932 was 94 ft. b.m., but by 1936 it rose to about twice that figure.[1]

Per capita consumption figures are useful as indicators of lumber use at different times and places, but they tell little about the relative movement of population and lumber production. Figure 37 shows the relative rates of change in population, lumber production, and pulpwood consumption in the United States on a logarithmic scale.[2] It is apparent that, from 1840 to about 1910, lumber production increased

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[1] A. H. Pierson, *Lumber Production 1869–1934,* United States Forest Service, Washington, D. C., 1936.

[2] D. Bruce and F. X. Shumacher, *Forest Mensuration,* McGraw-Hill Book Company, New York, 1935, discuss on p. 197 the use of logarithmic scale curves to show proportional changes which cannot be shown readily on ordinary graphs.

faster than did population. Since then, increase in population has continued at a declining rate but lumber production has actually fallen off. On the other hand, pulpwood production has increased since 1899 at a more rapid rate than population. Its rate of increase is now declining but is still faster than that of population.[1]

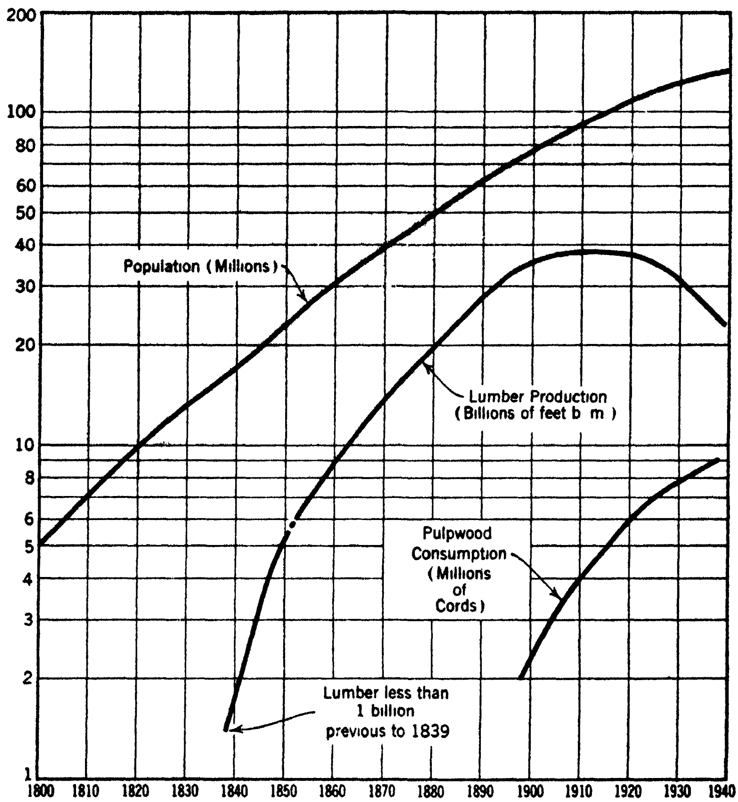

FIG. 37. Relative ratios of increase or decrease in population, lumber production, and pulpwood consumption in the United States. Population figures from United States decennial censuses; lumber from decennial figures to 1899, thereafter averages for decades (Tables 14 and 15). [Pulpwood includes imports from Table 2, p. 60, *United States Pulp and Paper Industry, op. cit.*] Pulpwood consumption is average for decades after 1919.

The different behavior of lumber and pulpwood consumption in relation to population is easily understandable if we remember that the greatest increase in lumber consumption occurred when a rapidly expanding population, living on an expanding income and moving into

[1] Although the figures used here include imports (Sec. 1C), the rate of increase is about the same for domestic wood only.

new territory, was building up its housing, manufacturing, and transportation facilities as fast as it could afford. Since they were largely capital expenditures of a durable or semi-durable nature, increases in consumption at such a rate could be expected only so long as population continued to expand numerically and geographically at a rapid rate. Once this plant was substantially complete, needs tended to fall toward the level of replacement requirements. Paper products, on the other hand, are largely consumers' goods bought on an expanding scale in response to increases in wealth and the development of new uses, some of which, as container board, are a less expensive substitute for lumber used in wooden boxes.

It is probable that the population of the United States will stabilize and perhaps begin to decline in the course of the next three or four decades.[1] In any event, the United States is not likely again to see the enormous use of lumber which took place in the past, except perhaps for short periods, caused by unusual conditions.

Future use of lumber as related to population will depend on where, how, and on what economic level that population lives.[2] Part of the decline in per capita consumption is ascribable to urbanization. People living in cities generally must be content with smaller living quarters than their suburban and country cousins enjoy. Nor can large apartment houses or great skyscrapers be built entirely of wood. There is now evidence of a decline in rate of urban growth, and population increases in smaller centers seem to be at a faster rate than those of the great cities.[3] If this continues, the field for construction of individual homes may be expected to increase. These and other population changes, such as large migrations from one region to another, causing a need for new housing and other facilities, will affect future lumber consumption without regard to the total size of the population, as will the prices at which lumber and other forest products are available. Past changes in price level may have been a secondary cause of the decline of lumber use; this possibility is discussed in the next section.

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[1] For a compact and non-technical discussion of this subject see Stuart Chase, *Idle Money, Idle Men*, Chapter 3, "Population Curves," Harcourt, Brace and Company, New York, 1940. See National Resources Board, 1938, *The Problems of a Changing Population*, for a more complete treatment.

[2] In times of depression obsolete housing is not replaced.

[3] W. F. Ogburn, "The Changing Pattern of America," *New York Times Magazine*, Oct. 13, 1940.

3. CONSUMPTION AND PRICES

In approaching this subject it is well to review the pertinent material presented in previous chapters. Demand, in an economic sense, is determined not by the total supply but by that which reaches the market at a price consumers will pay. As real prices increase, more and more consumers will refuse to pay them, even though the supply remains abundant (Chapt. VIII, Sec. 3*I*). Shortages in available supply of forest products have arisen in America as different localities and regions have been "cut out," but have been made good by imports from regions progressively farther from the chief consuming territory, which has remained largely localized in the northeastern United States (Chapt. XI). The resulting increased transportation cost (Chapt. X, Sec. 3) does not seem to have been offset by declines in conversion costs, and increase in stumpage costs have had to be reckoned with.[1]

About 1900 fear of a timber famine, expected when the remaining regions "cut out," apparently set in motion forces having a depressing effect on consumption. It was evident that, however successful the conservationists' call to arms, it could not produce new forest crops in less than a generation, even though it might check losses somewhat to existing supplies by such measures as fire protection. Therefore, large consumers, foreseeing loss of supplies or high prices, turned their attention to possibilities of wood substitutes. Manufacturers and financial groups, sensing a market, invested in research, manufacture, and sales promotion for such substitutes. The public almost came to believe it was praiseworthy not to use wood products. There is still propaganda to set aside huge forests to save them from the axe of the "wicked lumberman," who has his troubles carrying stumpage which was bought at boom prices (Chapt. XI, Sec. 3) on the assumption that the public would pay the asking price for lumber.

Today, forty years after the timber-famine cry was raised in the cities, the cry "timber" still rings through the woods. The day of exhaustion of virgin growth is pushed every so often into the future. The Pacific Coast and the South compete fiercely for a declining market, each claiming its business a losing one.

Failure of the nation-wide timber famine to materialize may be ascribed to various errors in calculation, but perhaps most to a visualization of forest exhaustion in the same terms as the clear cutting of a woodlot instead of to a process of gradual depletion by localities,

[1] H. B. Steer, *Stumpage Prices of Privately Owned Timber,* Technical Bulletin 626, United States Department of Agriculture, Washington, D. C., 1938.

regions, species, and grades, in which lowering of marginal standards of cutting and so-called accidental forestry (Chapt. X) would be to some extent compensating factors. Neither was the possibility of changes in demand, irrespective of supply or prices, given much attention.

It is pertinent to inquire whether the transference of major supply sources to distant regions has affected national consumption. Doubtless it has reduced it in the cut-over regions themselves. The economically prostrate stumplands of the Lake States are poor markets (Chapt. IX, Sec. 12). If it can be shown that this shifting of supply has resulted in significant increases in lumber prices with reference to prices in general, and to those of competing materials in particular, it would be reasonable to infer that this increase has had a depressing effect on national consumption.

Before discussing lumber prices as such, attention must be called to the types of price rises which cannot be shown in figures. The progressive exhaustion of regional resources, accompanied by that of the best timber and species within regions still producing, has resulted in substitution of species of lower value and in the lowering of standards in grading. Today No. 1 common pine is not as good lumber as it was thirty years ago; manifestly, therefore, the lowering of grades means the increasing of prices which do not show in quotations. Furthermore, broadly speaking, it means greater waste, higher labor charges in fabrication, and a less satisfactory final product. The same is more or less true in the use of marginal species. In other words, the tendency has been for lumber to become a more expensive commodity to use, irrespective of its selling prices.

Low-grade lumber has many uses for which high grades are unnecessary. When producing regions were closer to consuming centers, low grades could be marketed cheaply. Now, since it costs about as much to ship low- as high-grade lumber, the lower grades frequently cannot reach distant markets (Chapt. X, Sec. 3). This may compel one user to pay more for a higher grade than he needs, another to employ a substitute, a third to go without something he would buy at a lower price—the net effect being increased prices and lower consumption.

Keeping these hidden rises in mind, let us trace the history of American lumber prices as shown by price quotations.[1] The most compre-

[1] Capper Report, p. 39, 1920, gives a general report on lumber prices.

hensive price studies are by Compton [1] and Steer,[2] the first extending from 1860 to 1913, the second from 1900 to 1934. By the use of index, or, as he calls them, "relative" prices, Compton has shown that, despite fluctuations due to business conditions, the trend of lumber prices rose from 1860 to 1907. In that year they reached their peak and were nearly four times that of the 1860 level. The decline that followed the 1907 peak was temporary although the entire loss was not made up by the end of Compton's series. He also demonstrated that lumber prices had shown a generally rising trend, compared to general commodity and general building material prices, and that the periods of greatest increase corresponded largely to shifts of production sources to more distant regions.

It is noteworthy that peak prices coincided with the period of maximum lumber production [3] and occurred at the time when the combined production in the northeastern and central states and Lake States had fallen to hardly more than a third of the production of the southern and western states,[4] and continued rises were freely predicted.[5] Is it difficult to believe that trends of national lumber consumption have been affected by a combination of regional shortages and resulting price increases?

Compton wrote at a period when the lumber industry was entering a new phase, which was complete in the early 1920's. The West and the South, containing the last great timber bodies in the United States, held a stumpage monopoly. It was then expected that the South would soon "cut out" and leave the field to the West, with resulting higher prices.[6] However, thanks to underestimates and failure to consider second growth, the South has continued in large-scale production. This interregional competition doubtless has prevented greater rises than would otherwise have occurred. Nevertheless, the general rise continued, as Steer has shown, using prices from the United States Census and converting them to real prices (Chapt. VIII, Sec. 3*B*). The depression was still in progress when Steer wrote, but

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[1] Wilson Compton, "Organization of the Lumber Industry," *American Lumberman*, Chicago, 1916.

[2] H. B. Steer, *Stumpage Prices of Privately Owned Timber in the United States*, Technical Bulletin 626, United States Department of Agriculture, Washington, D. C., 1938.

[3] Table 14.

[4] Figure 32.

[5] R. C. Bryant, *Lumber Prices*, American Academy of Political and Social Sciences, Publication 1380, 1920.

[6] *Ibid.*

subsequent developments have again carried lumber prices to "new highs" although perhaps only temporarily, owing to wartime demands.

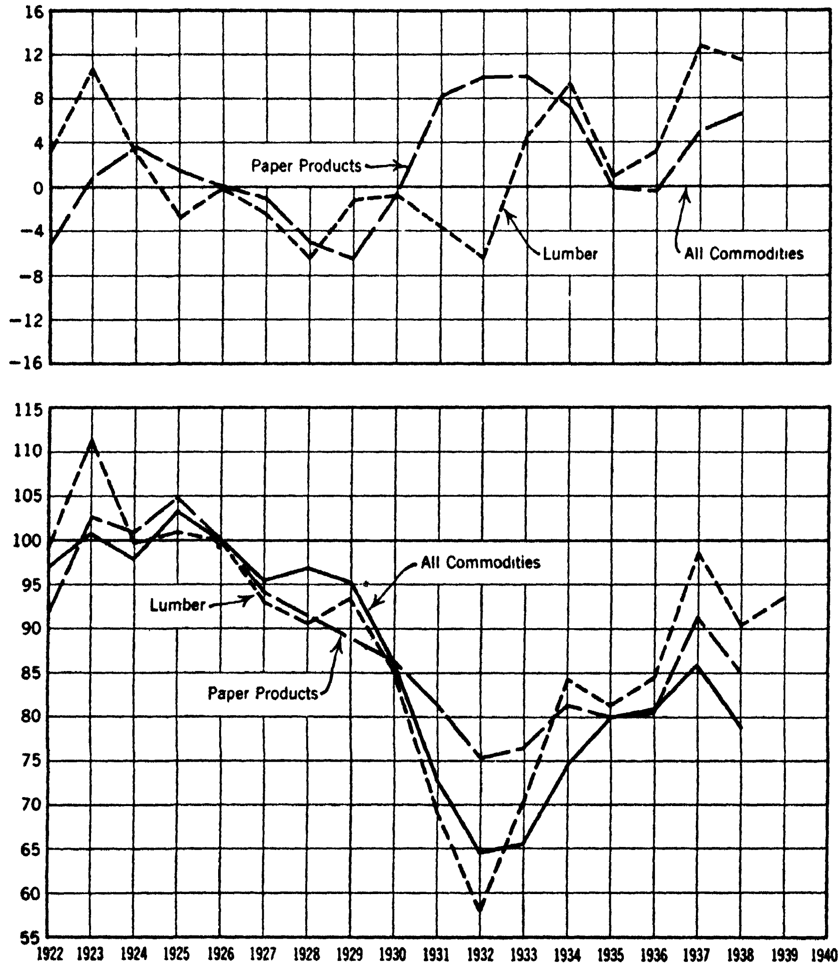

FIG. 38. Index prices of lumber production compared with index prices of all commodities, 1922–1940 (1926 = 100). Lower set of curves shows movement of all three indices. The upper set shows lumber and pulpwood in terms of relation to the all-commodity index only by plotting the difference between them on a plus and minus scale. [Figures from Table 17.]

Consumption, even in the best period of the booming twenties, continued its declining trend (Sec. 1).

Figure 38 shows graphically the movement of lumber prices as compared with the all-commodity index from 1922 to 1940. Being based on different price data, namely, the wholesale index prices of the

Bureau of Labor Statistics, which do not always agree with the census prices used by Steer, it nevertheless shows the same general movements (see also Sec. 4 and Fig. 40); namely, a rising trend of lumber prices, as compared with all-commodity prices, which has been particularly marked since the depression but which was preceded by a period of fairly close adjustment in the 1920's. Doubtless the various price changes in the past twenty years have been more influenced by trade conditions than by shifts in supply sources in the major producing regions, but it is evident that declining consumption has been accompanied by generally increasing prices (see also Fig. 14). We shall endeavor in the next section to study the post-depression period, comparing consumption with national income.

4. INCOME AND DEMAND

Since the higher the income of a person or a nation, the more commodities they will consume, it is desirable to compare changes in forest products consumption with those in national income, that is to say, with the net income of all businesses and individuals in the nation.[1]

Table 17 and Fig. 39 show in index form the changes in national income from 1915 to 1940. Its ups and downs with the prosperity cycle are easily observable, as are the corresponding movements of lumber and pulpwood consumption plotted on the same figure. The strikingly different behavior of these two commodities in their relation to the income since 1929 is largely because lumber, being chiefly producers and durable consumers goods, is much more dependent on the high purchasing power accompanying a high national income than paper products, which are largely temporary consumers' goods, bought

[1] These income statistics came from the United States Department of Commerce and refer to "income produced." They were accompanied by the following statement. "Estimates for 1929–1938 are by the National Income Section. Estimates for 1919–1928 are by the National Bureau of Economic Research, and have been raised to the 1929 level of the estimate by the National Income Section. Estimates for 1909–1918 are revisions of W. I. King's figures by the Brookings Institution, and have been raised to the 1919–1921 level of the adjusted N.B.E.R. figures." The following should be consulted by those interested in national income statistics.

W. I. King, *Income in the United States—Its Amount and Distribution*, National Bureau of Economic Research, New York, 1921.

Senate Document 124, 73d Congress, *National Income, 1929–1932*, 1934; *National Income, 1929–1935*, 1936.

United States Department of Commerce and its later reports.

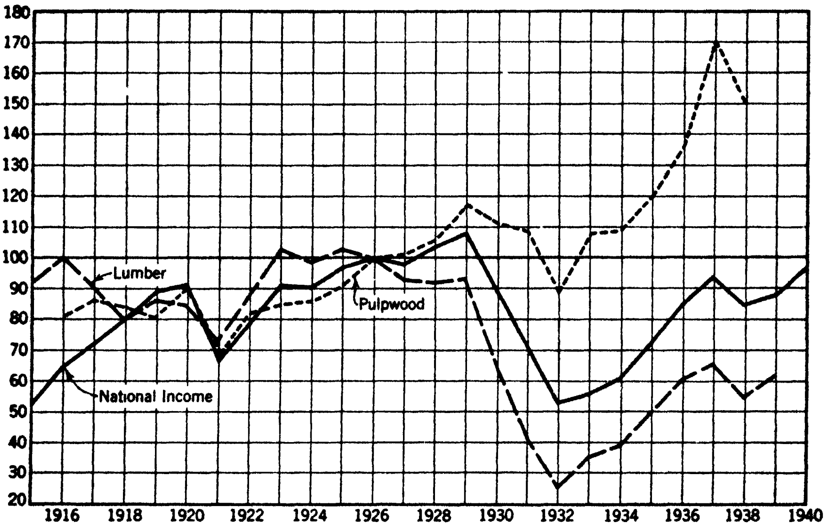

FIG. 39. Indices of lumber and domestic pulpwood production compared with index to national income, 1915–1940 (1926 = 100). [Figures from Table 17.]

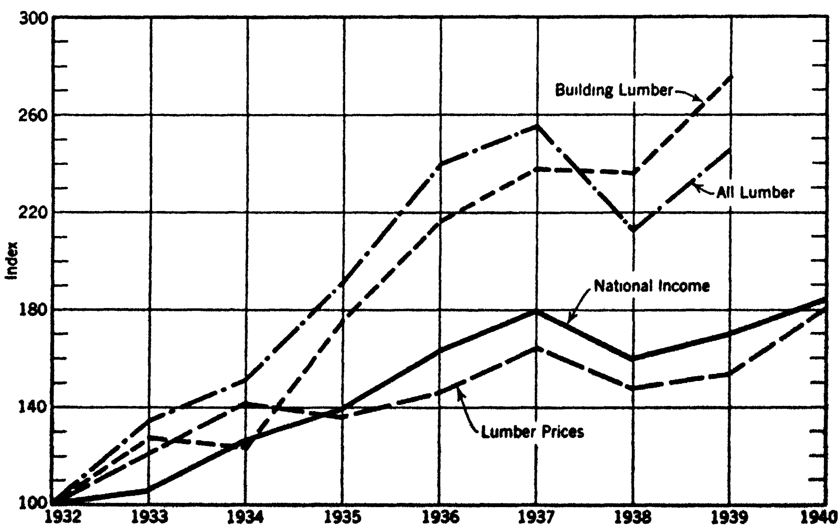

FIG. 40. Indices to relative increases in national income, total lumber consumption, building-lumber consumption, and lumber prices, 1932–1940 (1932 = 100). [Figures from Table 18.]

TABLE 17

National Income and Forest Production and Prices in Index Form
(1926 = 100)

Year	National Income [1]	Income Index	Production Indices		Price Indices		
			Lumber [2]	Pulpwood [2]	All commodities [3]	Lumber [3] (Per M. ft. b.m.)	Pulp and paper [3] (Various units)
1909	30.180	39.5	112.5	58.5			
1910	31.784	41.6	100 1	57.3			
1911	31.705	41.5	93.5	61.7			
1912	34.395	45.5	98.5				
1913	36.257	47.5	110.7		69.8	54.0	59.4
1914	35.253	46.2	93.9	66.3	68.1	49.9	58.2
1915	38.364	52.5	93.1		69.5	48.7	56.7
1916	47.399	62.1	100.0	80.9	85.5	55.1	89.0
1917	55.197	72.3	90.0	85.7	117.5	72.2	112.7
1918	61.005	79.9	80.0	83.8	131.3	83.5	106.7
1919	68.605	89.8	86.9	80.9	138.6	113.0	115.1
1920	69.457	91.0	85.5	91.3	154.4	165.2	181.8
1921	51.452	67.3	72.9	68.1	97.6	88.9	107.6
1922	59.720	78.2	88.6	81.9	96.7	99 1	91.6
1923	69.400	90.9	103.1	84.6	100.6	111.8	102.8
1924	69.221	90.7	99.4	86.0	98.1	99.3	100.7
1925	74.154	97.1	103.2	91.2	103.5	100.6	105.2
1926	76.345	100.0	100.0	100.0	100.0	100.0	100.0
1927	75.152	98.4	93.7	100.6	95.4	93.1	93.8
1928	79.100	103.6	92.4	105.6	96.7	90.5	91.4
1929	82.691	108.3	92.8	116.8	95.3	93.8	88.9
1930	69.104	90.5	65.5	111.1	86.4	85.8	86.1
1931	54.249	71.1	41.5	109.0	73.0	69.5	81.4
1932	40.089	52.5	25.5	89.1	64.8	58.5	75.5
1933	42.503	55.6	35.1	108.6	65.9	70.7	76.6
1934	50.634	66.3	38.9	108.9	74.9	84.5	82.7
1935	55.794	73.1	49.1	120.0	80.0	81.1	80.0
1936	65.226	85.4	61.0	136.7	80.8	84.5	80.7
1937	71.853	94.1	65.4	170.0	86.3	99.0	91.7
1938	63.993	83.8	54.4	148.5	78.6	90.4	85.0
1939	69.400	89.6	62.1		77.1	93.2	
1940	73.900	96.8			78.6	102.9	

1 Billions of dollars (see footnote 1, p. 239).
2 From Table 14.
3 United States Bureau of Labor Statistics.

in small quantities for current use. This conclusion is reinforced by a study of the price movements of the two commodities in relation to general prices in Fig. 38, which shows that, during the depth of the last depression, prices for paper products were higher in relation to general and lumber prices than previously.

In tracing the relation between national income and lumber production, it should be noted that from 1923 to 1932 the index for lumber production was declining in relation to the income index. Evidently, therefore, the American people were buying less and less lumber from a combined income which until 1929 was increasing. Both income and consumption hit bottom in 1932. Since then, judged by 1926 standards, both income and lumber production appear to have increased in about equal proportion.

However, by using 1932 as a base for comparison (Table 18 and Fig. 40), one sees a different aspect of the picture.

TABLE 18

INDICES TO NATIONAL INCOME, ALL LUMBER USED IN BUILDING AND LUMBER PRICES, 1932–1940 (1932 = 100)

Year	National Income Index [1]	Lumber Production Index [2]	Building Lumber Index [3]	Lumber Price Index [4]
1932	100.0	100.0	100.0	100.0
1933	105.9	135.3	128.0	122.2
1934	126.0	152.6	124.9	141.9
1935	139.0	192.5	175.9	135.6
1936	162.3	239.9	216.9	145.8
1937	179.5	256.1	238.2	165 2
1938	159.6	213.2	237.2	148.8
1939	170.0	246.0	276.7	164.4
1940	184.3			181.3

1 Data from Table 17.
2 Data from Table 14.
3 National Labor Manufacturers Association, *op. cit.*
4 Table 17, median figures between Bureau of Labor Statistics and Census Bureau used here.

Evidently, since the depression, Americans have augmented their rate of lumber purchase faster than they have improved their collective income. This is true for all lumber as well as for construction lumber, which is the largest lumber item (Table 16 and Fig. 33). It is also evident that, despite rises in price, discussed in Section 3, from

1935 to 1939 they do not seem to have been out of line with increases in national income.

Since building construction, largely for detached residential housing, appears to be the largest individual item in lumber consumption [1] and, perhaps in value and bulk, the most important of all forest product uses, it is well to examine the relation of such housing to national income. We can do so only very briefly because the subject of housing is vast and complicated and has a large specialized literature.[2]

TABLE 19

FAMILY INCOME CLASSES AND PERCENTAGES, 1935–1936 [1]

Annual Income	% of Families in Class	Cumulative Percentage
$ 1,250 and under	24.69	24.69
$ 1,250– 2,500	34.87	59.56
$ 2,500– 3,500	12.48	72.04
$ 3,500– 5,000	7.12	79.16
$ 5,000–10,000	7.36	86.52
$10,000–25,000	6.87	93.39
$25,000– over	6.91	100.00

1 United States Bureau of Labor Statistics, Incomes of Families and Single Persons, Table 2, p. 3, Serial R 829, 1938. Reprinted from *Monthly Labor Review*.

The ability to build or hire a separate house or a detached two-family home, for the city dweller at least—and the bulk of population is urban—requires an annual income well above the average, which in 1935–1936 was only $469.00.[3] (Large multiple-unit housing, built largely of other materials than wood, is the solution for low-income urban groups.)

An estimate of the potential market for wooden or largely wooden dwellings requires one of the number of families in the income groups able to afford new dwellings of this nature, either by ownership or rental. Table 19 is revealing in this respect.

1 There is plenty of evidence to support this statement derivable from Bureau of Labor Statistics reports on housing and from other sources which cannot now be presented here without unnecessary detail.

2 Technical Monograms 1, 1939 (*Residential Building*) and 3, 1939 (*Land, Material and Labor Costs*) of the National Resources Committee deal with small residential construction more largely than much of the housing literature, most of which is concerned more with large urban housing developments.

3 United States Bureau of Labor Statistics. See Table 19.

It is evident that of the 29+ millions of families in the country in 1935–1936, nearly 25 percent with incomes under $1250 could scarcely expect to build or hire a new home utilizing much lumber or other building material. Practically 60 percent of the families had incomes under $2500. If we accept that figure as a reasonable national average for the minimum income on which a private home may be financed safely, or for which it will pay private capital to build detached houses for rent, there remains only 40 percent of the families of the nation as potential customers for such housing. A much smaller percentage of them either are or are likely to be actual customers. Some are already satisfactorily housed, some prefer life in steel and concrete apartments, and some prefer to use homes below their economic level so that they can spend more in other ways.

Without going further, it is obvious that the more the national income is raised, the better the housing market should be, but it is also evident that rises falling largely in the lower and middle brackets will bring more customers into the market than those falling chiefly into the upper brackets. Of course it is also true that anything that cheapens house construction increases the market, but the price of lumber is only one item in housing. It appears to be only about 50 percent of the total cost of materials for a wooden house, and labor cost of house construction runs from 20 to 40 or more percent of the total contruction cost.[1] Naturally, prospective owners or builders must think in terms of total cost, which includes also the highly variable items of land cost and nearly always that of borrowing money.

5. TECHNOLOGICAL CHANGES

Science and invention have upset many traditional uses of materials, introduced many new products, and created many new wants, if not needs. Forest products, along with all other long-established products, have felt and will continue to feel the impact of these so-called *technological* changes.[2]

These changes may be listed as (1) the changes in manufacturing, transportation, and organization, resulting in more efficient manufacture and in the use of existing products from previously used materials, as improvements in manufacture and transportation and in

[1] The National Resources Committee, Housing Monograph 3, *op. cit.*

[2] Lewis Mumford, *Technics and Civilization*, Harcourt, Brace and Company, New York, 1934, is excellent background reading for this subject even though he nowhere discusses any of the specific problems of forest products.

construction methods of lumber; (2) changes in raw materials used in manufacturing established products, as the supplanting of linen by wood fibers in paper making; (3) developing new uses for existing raw materials: cellulose chemistry has produced entirely new textile fabrics such as rayon made from wood or other vegetable substances; (4) introducing entirely new substances made from a large number of raw materials and used for a great variety of finished products. Plastics, producible from animal, vegetable, or mineral materials and usable in some fields as substitutes, for both wood and metal, are a striking example.

Technological changes have both economic motives and economic consequences. The motives are to produce goods more cheaply, and hence at a greater profit, or to obtain profits by providing new types of goods or services for which there appears to be an actual or potential demand.[1] The economic consequences have increased the total income of society, owing to more rapid and economical conversion of a large number of raw materials and natural resources into a greater volume and variety of finished products than previously possible.

Technological changes have occurred ever since the first cave man lashed a sharp stone to a wooden club and produced an axe. They have followed certain patterns in past civilizations, as in our own, notably in the use of building materials. Buildings in both Rome and Boston developed with the advances in population and wealth from wooden shacks to apartment houses built of more enduring materials. Since the beginning of the nineteenth century these changes have been vastly speeded up, at first largely by improved mechanical methods for the transportation and manufacture of long-established products from traditional materials. Early in the period competition was between individual manufacturers who did not make extensive use of scientific research but were extremely successful in the production and marketing of huge quantities of goods at lower prices than had been possible before. By and large, the world prospered therefrom, as did the forest industries.

Despite declines in consumption due to the invention of steel ships and the new uses of metals and cement in heavy construction, forest

[1] This emphasis on the economic motive in no way denies that the fundamental inventions or discoveries on which technological changes are based often have been made by scientists or others for whom thoughts of economic gain were secondary or non-existent. Those who made use of the results were economically interested.

products more than held their own for general construction and were used for hosts of new products. The tempo of growth in population and prosperity began to decline early in the twentieth century and forest product consumption slackened.

Technological change, however, has speeded its tempo and shifted its emphasis from mechanics to chemistry. It is no longer simply a matter of improving the manufacturing processes of established raw materials, and of depending on relatively simple reactions of solvent or heat-treatment nature for chemical technics. Men aspire to break down all materials into their elements and to reassemble them in entirely new substances and forms. Mechanical technics, applied to heating equipment, made coal a superior fuel to wood. Chemical technics show the way to break both down to liquids and gases, so that it is now possible to use either one to propel motor vehicles in competition with petroleum products.[1] If all that we hear of the potentialities of plastics is true, they may well revolutionize traditional uses of all materials by breaking down the time-honored barriers between organic and inorganic substances, producing from either kind of substance finished products that may substitute for both in their conventional forms.

Competition is no longer so much between individual manufacturers of similar products from similar materials as between great financial and industrial groups, each using all the aid of research laboratories, advertising agencies, and sales promotion to acquire markets for new products that are made from new materials and by new technics (Chapt. VIII, Sec. 3*G*). The field is wide open.[2]

The present tendency appears to be toward the substitution of inorganic materials, or at least those derived from coal or mineral oil, for wood materials as sources of chemical products. The reason is the same as it is for the tendency to substitute metal handles for wooden ones on carpenters' hammers and metal for wooden office furniture.

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[1] Charcoal-gas generating plants, mounted on the running boards of trucks and automobiles, were introduced in France shortly before the present war; they are now said to be in wide use all over Europe, owing to the dearth of gasoline.

See D. D. Stevenson, "French Turn to Gasogenes during War Period," *Journal of Forestry*, Vol. 39, No. 5, p. 489, May, 1941.

[2] Articles by Koehler, Newlin, Markwardt, Sweet, Thelen, Curran, Sherrad, and Hunt, *Journal of Forestry*, September, 1938, give a picture of present research in Forest Products on which future technological changes may be based. They should be read in connection with this and the following section.

Both the raw materials and the manufacturing processes are cheaper because they permit bulk handling and have lower labor charges. This may not always hold true, as will be shown in the next section, but, in any event, technology holds many keys to the future and they may be used to open as well as to close doors on the use of forest products.

6. THE FUTURE OF FOREST PRODUCTS

The future use of forest products will be influenced, as in the past, by their abundance and price; by the size, distribution, wealth, and methods of living of the population; and by the forces of technological change. Only the future can disclose itself, but without attempting the hazardous role of prophet it is possible to state a few orienting points.

1. Modern methods of mass production demand huge quantities of cheap raw materials in order to produce large volumes of low-priced goods. Failing to obtain such supplies from one source, industry will seek them in another. It is reasonable to suppose that if forest products are abundant and cheap, demand will remain high. If they become rare, they will pass out of use except for limited and low-grade or luxury purposes.

2. The probability that population increases will cease in the course of a generation or two (Sec. 2) precludes much hope of a mounting demand from increases in numbers and raises the question as to how, where, and on what economic level the bulk of the future population will live.

There is some evidence that it may be less crowded into great metropolitan centers than it is today. Its general economic level is anybody's guess. Some believe that a stationary population must live necessarily on a lower economic plane than on an increasing one because it lacks the opportunity for continuous investment and labor in new production equipment to provide more goods for more people; others say that, by proper social and economic organization, a stationary population can increase its living and consuming standards indefinitely.

A conservationist might suggest that a people intelligent enough to conserve and develop their country's natural resources—soil, water, forests, etc.—would have ample raw materials and power sources from which to produce an abundant and wide variety of finished products at low cost, on which to live on a high consumption level—provided only its population was large and wealthy enough to exploit those re-

sources properly but not so large as to necessitate their destruction in order to obtain the immediate necessities of life.[1]

3. In any event, technological changes will continue. Although their direction and scope are unpredictable, we may be sure, first, that, as in the past, they will move the fastest in those directions where the greatest energy is applied in the form of creative brains backed up by capital; second, that, since technology is motivated by economics, in the long run changes will favor those raw materials whose extraction, transportation, and conversion to finished products are the cheapest.

The future uses of forest products must be considered in the light of the above statements. In so doing we shall deal, first, with those used as wood and, second, with those used as a source of derivative products.

Lumber and allied wood products have been and still are one of the chief construction materials; indeed, building construction is the most important use of wood (Table 16, Fig. 33). This is due partly to its cheapness as a material and to the low cost of wooden construction and partly to its extreme adaptability, flexibility, and other inherent qualities not possessed by competing materials. There is nothing necessarily permanent in this situation. After all, no other building material seriously has challenged the use of wood for residential construction. Notwithstanding, housing experts condemn present-day housing as neither efficient in construction nor adapted to modern living. Until the present war submerged all peace-time considerations, many claimed that the development of really modern housing would finally lift America out of the economic doldrums. Small houses of all sorts of architecture and materials have been designed and occasionally have been built; but, to date, the problem of the mass production of housing, satisfying to both the pocketbooks of producers and consumers and to the potentialities of modern living, has not been solved.[2]

It has been claimed that this situation has been brought on because the manufacturers and distributors of lumber products that are used in house construction and the contractors and organized laborers who

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[1] An overpopulated country, living on a low economic level, such as China, cannot afford to conserve its natural resources any more than a $4.00-a-week clerk, living on his wages, can save for a rainy day.

[2] The recent urgent demand for war housing has made necessary some use of prefabrication and mass production methods. The designs and construction systems evolved no doubt will contribute to post-war developments in housing.

use them have not cooperated to produce housing that is both inexpensive and good.[1]

However this may be, the problems of low-cost small housing will still be with us after this war, and the lumber industry will have more active competition than it has at present from war-building industries hungry for a peace-time market. It is well to remember that superior or even cheaper materials, inefficiently handled, may give place to those produced and used by groups willing to make technological advances in organization, manufacturing, and construction methods.

It appears that the future of lumber as a housing material is largely in the hands of the lumber industry that furnishes its basic raw materials and of the contractors and builders who use them. This is also true of other wood products used in housing, such as plywood, wall board and insulation materials, turpentine and paint. It does not seem too much to hope that if all the groups comprising the building industry would reconcile their interests and pool their resources, they could produce modern wooden houses that would take advantage of all the good qualities of wood and overcome its less desirable ones. The basic studies necessary would include research in technological, financial, and organizational problems of housing and of the construction industry and should include studies of prefabricated housing as well as of conventional types.[2]

As to certain other uses of wood in its natural state, such as railroad ties and poles for telephone and electric light use, these advantages are so manifest that, if wood preservatives are used, there seems no reason why wood should ever be supplanted, provided it can be obtained in sufficient quantities at reasonable prices. Should it become scarce and high priced, cheaper substitutes will be developed even if they are not so good. In a last analysis, the decision of large industrial users is based on ultimate costs, including maintenance and replacement.

As to other long-established wood products, it is doubtful whether their manufacturing and distribution processes or the equipment used in their consumption has even begun to reach maximum efficiency. A few random examples are sufficient. Perhaps the limits of mechanical

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[1] Thurman Arnold, "Statement of Anti-Trust Activities in the Building Industry," *New York Times*, July 8, 1939.

[2] E. C. Jahn, "Does the Lumber Industry Need a Research Program?" *Journal of Forestry*, Vol. 37, No. 8, p. 595, August, 1939. The editor raises the point as to whether the industry could finance an adequate research program.

efficiency of the large sawmill have been reached, but the proportion of the lumber cut from them is declining (Chapt. X, Sec. 5). The mechanical inefficiency of portable mills is well known and a cause of economic loss wherever they operate. Many improvements are still possible in the kiln drying of lumber for mills, big and little. The resulting economies would enable the conservation of material and lower prices.

The recent invention of so-called "wood connectors"—metal joints designed to connect round or squared timbers and beams, increasing the strength of the joints and decreasing erection costs of wooden towers, trusses, and frames—enables wood to compete with metal in types of construction where it has been at a disadvantage, although as yet aggressive marketing campaigns are required to build up consumption.

Wood is still burned in archaic stoves, which Mumford[1] would call "paleotechnique," and is giving way, even in forest regions, to coal and oil burned in modern equipment. Experiments show the possibilities of developing woodburning stoves and even central-heating units for household use on thermal principles, making possible slow and even combustion, coupled with low fuel consumption. Such equipment would be a boon in all forest regions where other fuels are expensive and perhaps destined to become even more costly.

Experiments indicate that methods may be devised for the use of wood fuel in central-heating plants of large buildings, using it in hogged or briquet form or possibly as charcoal. What seems to be needed is efficient mechanical stokers, and improved organization in cutting and transportation. These developments, by creating an active market for low-grade wood, would encourage thinnings, thus reducing the length of rotation and increasing quality as well as lowering the cost of production (Chapts. XIV and XV).

The American naval stores industry is susceptible of much improvement along mechanical, chemical, and organizational lines. Despite vast improvements in the field technic of collecting gum, inefficient stills, poor chemical control, lax grading, poor financial and merchandising methods have caused it to lose ground as compared both with the French industry and with the industries better organized and financed, using coal and oil as raw materials.

It is unnecessary to give further examples of opportunities for improved efficiency in all the older wood-using industries. Only by ef-

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[1] *Op. cit.*

fecting such efficiencies can they hope to withstand the terrific impact of twentieth century technology and competition.

As to the newer forest industries, based largely on chemical processes of breaking down wood structures to extract cellulose and the various chemicals used in synthetic products, the oldest and largest of them, the pulp and paper industry, seems the most assured of continued markets and growth, reasonably free from fear of competition. New uses for paper stock are constantly being developed. If the industry has ample raw materials, its place seems assured although very high prices may activate the competition of vegetable fibers from agricultural crops. Its continued growth will probably depend in large part on the income and living standards of the population.

In concluding Section 5, the subject of the future uses of wood, as sources of raw materials for increasingly important chemical and synthetic products, was left on an apparently pessimistic note with the statement that they seemed to be losing ground to coal and petroleum products because of economies of production due to ease of bulk handling. But let it not be forgotten that the law of diminishing returns runs against both mine and well. Doubtless, new oil and mineral deposits may be discovered in remote parts of the world; doubtless, improved extraction methods will bring into production lower-grade deposits, and those deeper in the earth, so that the exhaustion of such materials is a matter for the remote future; but the marginal limits of distance from consuming centers and of depth below the surface cannot be increased indefinitely without, sooner or later, making it cheaper to use materials that are renewable from the earth's surface at points near where they are needed.

Many of these newer products can also be obtained from field crops. Apparently no studies have been made of the relative costs of production for cellulose and similar products from agricultural and from forest crops but three factors are bound to be important: relative land, labor costs, and annual yield per acre. Forest land is not in competition with cropland; they are in different classes. Land used for field crops is more costly and can produce a wider variety of products. The high labor costs of forestry have been discussed previously (Chapt. IX, Sec. 10), but those of agriculture are higher still. In a stationary population, living on a high economic level, labor would not be too plentiful. However, there are indications that, for cellulose, higher yield per acre per annum may be expected than from field crops.[1]

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[1] Henry Bull, "Loblolly Pine vs. Cotton: A Comparison of Annual Cellulose Production per Acre," *Journal of Forestry*, Vol. 37, No. 7, p. 570, July, 1939.

In conclusion, two facts seem to stand out, namely, that the more abundant and cheaper a product, the more it will be used; the higher class of brains and the more capital that is expended in improving its usefulness and the efficiency of its production, the more it will be able to withstand competition. Within limits, the future of forest products is in the hands of the industrial and financial groups that stand to gain the most from their continued use.

7. PRICES AND THE FUTURE

It is idle even to speculate on forest products prices in the distant future in terms of dollars and cents, or even in their relation to those of other commodities, but it is possible to foreshadow in some degree the nature of the cost structure upon which they will be built.

Their present and past structure has been reared on the costs of purchase, conversion, and transportation to market of timber which was grown by nature at no expense to its owners. It is often assumed that, when virgin timber is exhausted, capital will be invested in growing new supplies, and the cost of so doing will be added to those of harvesting and transportation and consumer prices will be adjusted accordingly.

This theory contains elements of truth in that all production costs, in the long run, must be reflected in final prices, but it neglects important modifying factors: first, that, if the resulting price is too high, consumers cannot or will not pay it; second, that it will be long, if ever, before all natural growth forests are exhausted. It is only a question of time before the remaining virgin stands in America will be gone, but there are unexploited virgin forests in other parts of the world (Chapt. IX, Sec. 4), and volunteer second-growth timber is even now entering the market. Neither virgin timber in distant countries nor uncared-for second growth near at hand bears a growing charge. Even assuming the almost universal practice of forestry, some owners will liquidate as forest land is cleared for agriculture and for other purposes; owners are hard pressed for cash, or farmers who do not keep books sell their timber, etc. Forestry-grown timber will be in competition, active or potential, with all these sources. The price will still be set by the cheapest source. Only as forestry-grown supplies are cheaper or better adapted to specific uses will they command the market.

Assume a consuming territory, a nearby region where forestry is practiced, and a distant one with ample virgin timber. If transportation balances cost of growing and if conversion costs are the same,

they can deliver their products in the consuming territory on an equal footing, except that the low grades of the distant regions are penalized (Chapt. X, Sec. 3). If the virgin timber comes a greater distance it will be at a disadvantage and vice versa.

Since national policies, economic, political, or military, frequently operate through tariffs and through export, import, and other regulations to prevent the free interchange of goods, the question of large-scale imports of forest products may never be settled on a purely economic basis. Present trends seem all in favor of economic nationalism, which means that foreign trade is discouraged in the interest of home production.

Assuming, therefore, that conditions remain unfavorable to large overseas timber imports to the United States, the basis of the general price structure will probably remain about as now until the major remaining source of virgin supply in the Northwest is exhausted. This basis, as we already know, is in the competition between the southern and western regions, in which the West has the advantage of a supply of large and high-quality stumpage, where mass production is possible, but has the disadvantage of distance from the chief consuming centers. The South, which is much nearer consuming centers, suffers from poorer and less economically exploited stands, made up more and more of second growth.

Exhaustion of the Pacific forests, by the removal of most of the high-grade softwood timber from the market, will require considerable readjustment in lumber and probably other major forest industries. This will tend to shift production centers to second-growth forests, most of which are east of the Mississippi and which are increasing in volume from natural growth, aided by fire protection and, here and there, more positive forestry measures. Since they lie nearer major consuming centers, transportation charges should be lower.

The new price structure will have to take account of this and of the fact that large-sized, high-grade timber is rare in second-growth forests. Regardless, therefore, of the level on which prices establish themselves in relation to present ones, the spread between those of high and low grades will doubtless be greater than today and the amount of available high-grade material far less. The producer, having it in quantity, will enjoy a competitive advantage both in superior product and in lower milling costs (Chapt. X, Sec. 2).

Consumers care little whether their timber supplies are grown by nature or are under the devoted care of college-trained foresters; they seek to obtain the kinds and grades best suited to their purposes and pocketbooks. Silviculture's justification is that it can obtain a larger

volume and a higher grade of product in a shorter time on a given area of land than can unaided nature. This, coupled with the consequent lower harvesting and milling costs, should give forestry-grown timber a competitive advantage in a market where the bulk of the supply comes from untreated second-growth forests, composed of trees of smaller size (and lower grade and in less dense stands), which are more expensive to log than those that are forestry grown, even though the foresters' products bear a growing charge which nature's does not.

Although price levels cannot be forecast for the distant future, it is possible to discuss the sort of prices which may be expected to produce the best results for both producers and consumers. It is quite natural that those interested in producing or harvesting forest crops should desire to see the price level high This would seem to make their business more attractive and thus promote the systematic practice of timber growing. Doubtless, for certain largely indispensable products this is true, but it may be questioned whether, in view of the fact that in these days substitutes are possible for nearly everything, the prospect of very high prices in relation to substitutes, actual or prospective, would be desirable for the forest industries as a whole. Modern industry tends to operate on the basis of low-cost products marketed in large volume. There is no apparent reason to expect this trend to be reversed. An abundant supply of forest products, marketable at reasonable prices as related to general prices and to prices of competing materials and products, therefore would seem a better guarantee of large markets than a high price level which is bound to restrict consumption. The more stable that level in relation to general prices the better because it gives both consumers and producers a better basis for planning future expenditures. Of course, it stands to reason that, if forest products prices find a level at which it is not profitable for private industry to grow trees, forestry is possible only as a public or a publicly subsidized business. If high prices put wood on a luxury level, it seems equally clear that, while there may be a small and highly profitable business for a few producers, a huge industry is far less likely. Possibilities of price modification, by large-scale production on public forests, and government price controls of forest products are discussed in Chapter XXI.

REFERENCES

Statistical Sources for Quantities, Values, Uses, and Prices of Forest Products

The United States Department of Commerce in cooperation with Forest Service: *Forest Products—Lumber, Lath, and Shingle Series,* published annually for

non-census years. Gives production data by states and species and, occasionally, other groupings and minor products. The Census Bureau published in its *Industry Series* for each decennial census "The Principal Lumber Industries" which gives the same type of information for the year preceding the census, but in greater detail. (The Forest Service issued a mimeographed summary of all lumber production from 1869 to 1934 in that year and has followed it since with a similar annual summary.) The Department of Commerce also publishes as part of its Census of Manufactures annual or periodic reports on (1) pulp and paper products and (2) a variety of secondary products classified by uses.

The above also contain data on the total value of products and on the unit prices at the mill. The United States Bureau of Labor, Department of Labor Statistics, publishes a monthly and annual series of wholesale index prices of important forest products and also an index to volume and construction costs in the building industries along with the general series of index prices. All the above usually are summarized with data on employment in the forest industries in *Statistical Abstract of the United States,* published annually by the Department of Commerce.

Occasionally the Forest Service publishes special bulletins which go into detail as to the production and consumption of lumber or other forest products by states or regions.

CHAPTER XIII

LAND AS THE BASIS OF FOREST ENTERPRISE

It is an economic truism that all wealth has its beginning in the earth, including both land and its water. The wealth of the seas can be exploited only from land. When we consider land from the point of view of forestry, as the basis of tree growth, we must examine many aspects of its value, such as its fertility, location, value for other uses, cost, and legal status. In doing so, we shall confine our attention solely to timber-production forestry since the land aspects of protection, recreation, and wildlife forestry are considered in Chapter XVI.

1. LAND AS RELATED TO FORESTRY AND LUMBERING

Foresters and lumbermen think of land from different viewpoints. The forester wishes to produce recurrent forest crops on the same land at a cost sufficiently low so that he can sell them at a profit without impairing the productive capacity of the soil. His is the long-time point of view, concerned with both the land and its product. The lumberman is not interested in the land, only in the timber on it. He will not buy land if he can get stumpage on favorable terms by other means (Chapt. X, Sec. 4) unless he thinks it can be sold at a profit after the timber has been removed. This is no longer easy to do (Chapt. XI). But both lumberman and forester must reckon land cost as one of their costs of production. Once land is purchased, its cost, plus the carrying charges in the form of taxes and protection, plus interest on them, becomes a fixed cost that must be charged against each unit of product grown or cut from it.

The lumberman must pay these costs from a single crop of timber; but, in theory, the forester can take as long to pay for his land as he wishes because, once his operations are on a sustained-yield basis (Chapt. XV), his land is continuously productive and will yield the necessary return to meet interest charges. Practically, the purchase price of land must be paid as soon as possible to reduce interest charges. This may be difficult when a producing forest is being built up on cutover or second-growth land. In addition, to avoid a load

that might break him, the forester must purchase land that not only is suitable for tree growth but also has a low cost and a low tax rate (Sec. 5).

2. NATURE OF VALUES IN LAND

Before going into the appraisal of land for forestry purposes, it is desirable to discuss the basic nature of land values. They are of three sorts: (1) those based on what the land will produce in tangible or intangible products (productive value); (2) those based on the advantage of its situation for specific purposes (geographic or strategic value); and (3) those based on its use as a means of protecting values in other land or property (protective value).[1]

The productive values of a piece of land come from the crops, forests, minerals, water resources, housing sites, or scenery it bears. Its geographic or strategic value is due to its position, independent of its products. Land that commands access to resources or to the use of other land has geographic value, as land surrounding water holes in a semi-arid grazing country. Broadly speaking, all the land in greater New York has a high geographic value because of its proximity to one of the world's greatest harbors. Land that protects the use or producing capacity of other land has protective value, as a sand bar off a harbor which protects shipping at anchor from storms.

One piece of land may have all these kinds of value, which may be conflicting or complimentary. It is impossible to use the same piece of land for a steamship dock, a corn field, and an apartment house, but the sand bar may also serve for a seaside park. These values may be provided by nature, or by man, who may create, alter, or destroy values. By putting coal into the ground, nature may give land where it is found a high productive value, which can only be realized when man's technical skill and economic development make it possible to dig and use the coal. Once it has been used, that particular value is destroyed. Nature created the mouth of the Hudson for a great harbor; she was equally generous when she ran the Potomac and the James into the entrance of Chesapeake Bay at the same point. But man, by digging canals and thus joining the Great Lakes and the Mississippi with the Hudson, altered geography and made New York a continental port and left Norfolk a regional one. The effect on comparative land values may be imagined. Man has created values in deserts by irrigation and has destroyed them in fertile land by draining away the water. He has created value by the

[1] Although case 3 may be treated as a special form of case 2 and both are special forms of case 1, an analysis is facilitated by considering them separately.

expenditure of brains and capital and has destroyed it by failure to use them.

The value of a piece of land is a component of its productive and its geographic values. Two equally fertile fields will not have equal value if one is twice as far from market as the other. The more remote land is from the market for its products, the less value it will have.

When one piece of land has a protective value in relation to another, their values obviously cannot be considered separately. If the producing value of an acre of cropland can be destroyed or seriously impaired by the destruction of adjacent forest, the woodland has a value outside that of the forest products it yields. Conversely, it must be recognized that the value of the cropland may be destroyed or diminished by the way the forest is handled (Chapt. XVI, Sec. 1).

Any use that impairs the capacity of land to produce will reduce its value, unless it can be used for more remunerative purposes irrespective of this loss. If the top soil from a field is wasted, this will reduce its producing capacity, but, if the field should be sold for a factory site, it will be of no consequence and will not affect the price paid.

Land values tend to increase with increases in population and wealth because they create a greater demand for land and because land can be used in more remunerative ways. City real estate may bring in more revenue per square foot than will farmland per acre. In the long run, land generally is put to its most financially profitable use unless it has previously been handled in such a way that its highest value has been destroyed or impaired, as where the removal of all the trees from a lake shore spoils it for recreational purposes.

Since the producing capacity of land often has been impaired or destroyed by the destruction of its forests and the impoverishment of its soil, the general, upward course of land value, mentioned above, has been paralleled by a fall in the values of lands destructively used. When society has been prosperous, as during the nineteenth century, this loss has been masked by increases in the value of other land, but it is always felt at a less prosperous period, which it helps to bring about. No one thought much about the impoverished agricultural land in the 1920's, but they became a national economic problem in the 1930's.

3. PUBLIC AND PRIVATE INTEREST IN LAND

Because the way land is used affects not only its owner but also his neighbors and the public, it has usually been necessary for governments to exercise various controls over land ownership, distribution, and use. An owner wishes to use his land in order to get the greatest economic return; his neighbors wish him to use it in a way that will protect the value of theirs; and the public needs to have all land kept as productive as possible so that revenue from taxation will be adequate, the national income will be high, and social welfare will be advanced.

In order to accomplish these objectives, various kinds of control have been set up in democratic countries.

1. The public retains title to certain types of land, necessary for public uses, such as land between high- and low-tide levels.

2. It has the right of *eminent domain* or *condemnation* by means of which it can take land that is necessary for the discharge of governmental functions, such as providing for national defense and public transportation.[1] This is done by process of law, and the owner is compensated.

3. Subject to specific legislation, it limits the use to which an owner may put his land, if this use will injure his neighbors or the public. This right is a part of what lawyers call the *police power*. Sanitary and building codes and zoning ordinances are examples of such legislation.

4. It decides whether a landowner's actions are detrimental to his neighbors. This function is partly legislative and partly judicial. It sets up categories of acts that are unlawful because they affect neighboring owners adversely, such as diverting all the water from a stream. Through the courts, it adjudicates disputes among neighboring landowners as to their respective rights.

5. It regulates the transmission of land by inheritance. In countries like Great Britain it promotes building up large estates and keeping them intact by laws of primogeniture and entail, which assign all property to the eldest son and prohibit its division or sale. In the United States and France it favors wide distribution of land ownership by providing that all the heirs shall inherit an estate in legally prescribed proportions. Sometimes governments deny to aliens the

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[1] This power is granted sometimes to public utility corporations which need land for public purposes, as railroad rights-of-way.

right to own land in order to reserve the benefits of such ownership to its own nationals.

6. Through the power of taxation, it may charge an owner so much per year for the privilege of owning land, and take it away from him if he fails to pay. Theoretically this does not prevent an owner from using his land as he wishes, but actually it may because the tax usually is levied on the basis of its most profitable use. Thus, urban land is taxed too highly to justify its use for agriculture. Farmers in the vicinity of growing cities are often, as the saying goes, "taxed off the land."

The strict application of these powers almost could abolish private initiative in the use of land, or even private ownership. Yet, since modern democracies grew up under the late eighteenth century and early nineteenth century economic theory of "laissez faire"[1] (with its political philosophy expressed by the proverb, "He governs best who governs least"), custom and popular opinion have forced governments to exercise their sovereignty very leniently, so that the individual landowner usually has had an advantage over both his neighbors and the public.

Nevertheless, the transition from an agricultural economy to a complex urban and industrial one gradually has extended public control over land use, both in the form of increased public ownership of land and in more regulation of private land use. This has come about because of specific failure on the part of private individuals to administer their property in consonance with the public good. Laws requiring landowners to get permits to burn brush and to take precautions, lest the fire burn over the property of their neighbors, have been passed not because of any desire to socialize forests but to prevent the destruction of values and property. Such laws are typical of control legislation.

Basically, the struggle to extend or diminish public control over land use is a struggle between individuals and groups for economic advantage. Its real nature is often camouflaged by much talk about "rugged individualism" or "the rights of the common man." Those immediately concerned may and often do take different views at different times on the same basic question as they think their advantage dictates. A man who has already installed a septic tank for his household sewage may oppose municipal ordinances that require him

[1] French for "let alone," meaning, in this instance, the theory that private economic activity should not be interfered with and that, left entirely to itself, it will produce the best results for society as a whole.

to connect to a public sewage system but, at the same time, favor the purchase of land for a nearby public park, believing it will increase the value of his property. Many who take part in such struggles do not understand their economic implications and take sides on an emotional basis because they "are unalterably opposed to government ownership" or "believe that all means of production should be public property."

In such struggles, the public interest usually is supported by a personally disinterested group, such as a public health or community planning organization or a forestry and park association, that understands the difficulty of persuading private owners to use their land to the best social advantage and that wish to force the government to use its latent authority to make them do so.

A democratic government is supposed to be responsive to the will of its people. Often the viewpoint of its servants corresponds more or less to that of the dominant members of the group that elected them, although the viewpoint of civil servants and appointees to technical positions, who are only indirectly responsible to the electorate, is usually the outgrowth of their personal interests and their basic thinking which may be favorable or unfavorable to the extension of public control even when their own fortunes are more likely to be benefited by its extension than by its limitation. It is by the interplay of these economic, social, and political forces that the questions of the extension of public forests (Chapt. XX) and of the public regulation of private forests (Chapt. XXI) finally will be decided.

4. LANDS SUITED TO ECONOMIC FORESTRY

Successful forestry involves the expenditure of labor and capital on lands that have a high producing capacity, that are suitably located in reference to markets, and that can be bought and held at low prices.

Forest soils vary widely in producing capacity; on some the growth rate is so slow, the final yield so small and poor in quality, that it may never be economically justifiable to grow timber there. Forests at extreme altitudes or on extremely poor soils belong in this class. On the other hand, land well suited to tree growth, especially for the more valuable hardwood species, is also good for agricultural purposes, and will yield a much higher annual return when so used. Usually it is taxed on a valuation that would preclude any profit from its use for forestry. The more remote the land is from market, the higher must be its producing capacity; the closer it is, the poorer

it may be (Chapt. X, Secs. 2 and 3). From an economic point of view, we have four classes of forest land: one that is submarginal because of poor soil; one that is submarginal because of physical and economic inaccessibility. Frequently, land at high altitudes is submarginal both because of poor growing conditions and because it is inaccessible. A third class would be unprofitable because of high land values. The fourth type is economically suited to forestry and may be called the "profit area."[1]

The limits of these classifications are ill defined because it is difficult to determine future demands and costs, which are and always will be subject to change. The greater the demand for forest products, the less important are low-growth capacity, high land values, and distance to market, and the greater becomes the area of land economically suited to forestry. A decline in the value of physically suitable lands, in regions where other conditions are favorable, may also expand the area suited to forestry on an economic basis. This appears to have happened over large sections of the eastern United States, owing to the abandonment of lands, formerly used for agriculture, which are both well suited to tree growth and conveniently located in reference to markets. Conversely; decline in demand for forest products or an increased need of land for other purposes may restrict this area. Other factors, such as change in transportation or production costs, demand for one kind of timber as opposed to another, may also expand or contract the profit area. This area is divided into high, low, and medium areas, according to the same set of economic, geographic, and physical factors that determine the area itself.

5. LAND COSTS AND PRODUCING CAPACITIES

The total land cost of raising a crop of timber includes land purchase price plus interest on it and annual taxes plus interest on them.[2] Over a long period, the sum of these costs will be considerable and the purchase price of the land may be the least of them. The best

[1] These profit areas have no necessary relation to areas of commercial forest, frequently referred to in Chapter IX, which are so classified because the land is physically suited to produce commercial timber. It is not necessarily economically suited. The physically suited area is much larger than that which is economically suited.

[2] The total cost of purchasing and carrying land to any period in the future can be determined by uniting formulae 3 and 5; thus $V_n = V_0(1.0p^n) + [AR(1.0p^n - 1)]/0.0p$, letting V_0 equal the purchase price of the land and AR the annual tax, the interest rate being determined by the rate at which money for the enterprise is or could be borrowed (Chapt. VI, Sec. 11).

way to study these costs is to assume certain land prices, interest, and tax rates and to graph them, as is done in Figs. 41, 42, and 43.

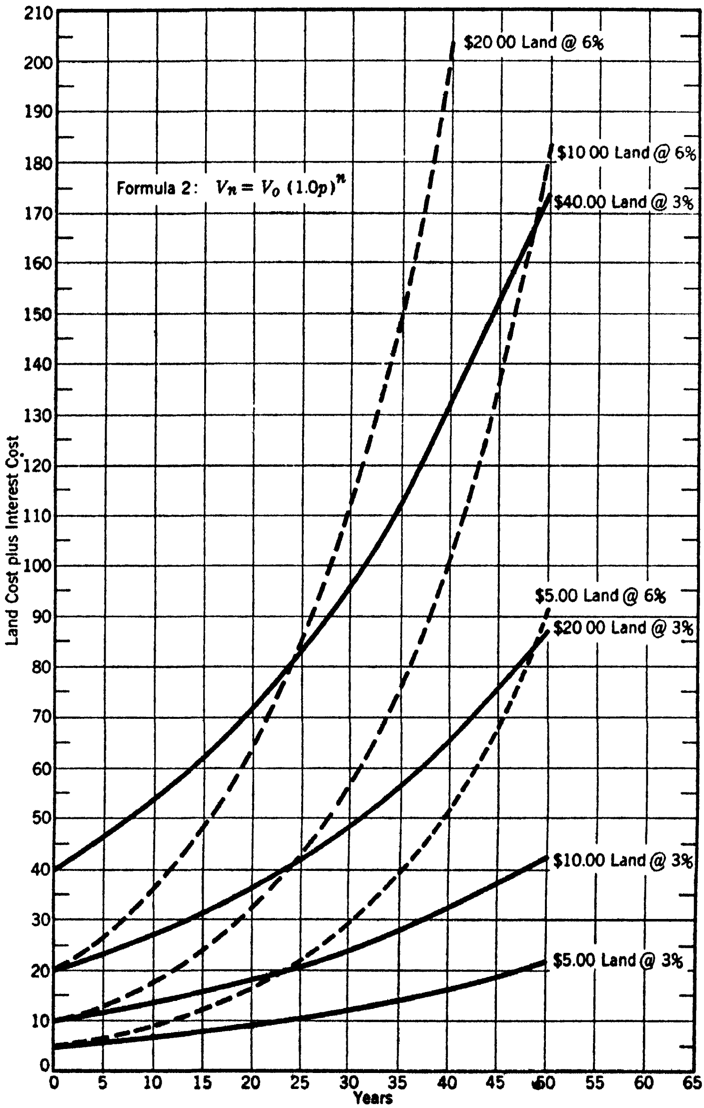

FIG. 41. Land cost plus interest cost at 3% and 6% on lands costing $5.00, $10, $20, and $40.

Figure 41 compares $5.00, $10, $20, and $40 land, each at 3 and 4 percent interest for 50 years, and makes it apparent that a high interest rate on a lower land purchase price sooner or later means a

greater investment in land than a lower interest rate on higher-priced land. Figure 42 shows taxes of \$0.10, \$0.20, and \$0.30 per acre for a

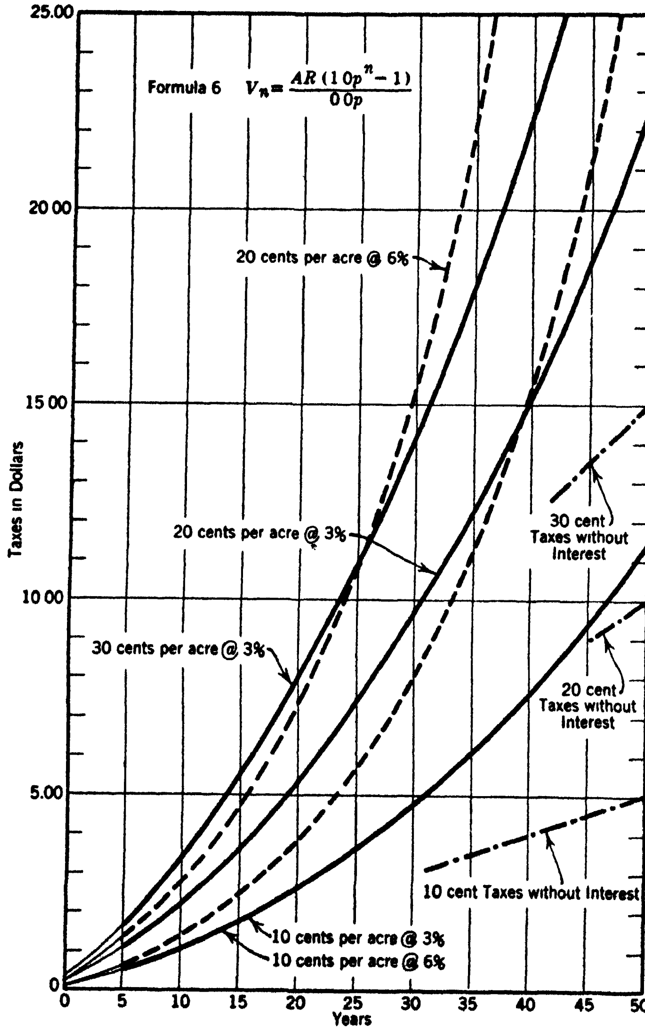

FIG. 42. Compound cost of taxes of different amounts and at different interest rates for different numbers of years, compared with the sum of taxes without interest for equivalent years.

50-year period at 3 and 6 percent and makes clear that even a small annual tax amounts to a considerable sum when compounded over a long period. Figure 43 shows a \$0.20 tax at 3 percent becoming greater in amount after 45 years than the cost of land at \$5.00 per

acre plus 3 percent interest. It is also obvious that in time the $0.10 tax at 3 percent would cross the land-cost curve. In other words, the

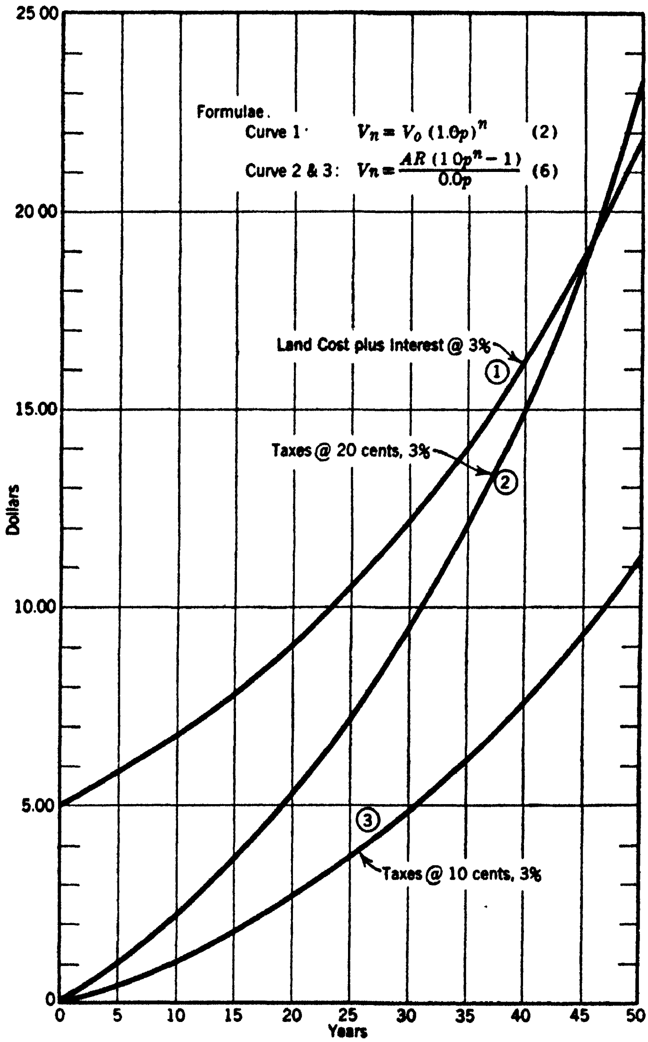

FIG. 43. Relation of investment cost in land to investment cost in annual taxes, both compounded at 3% on $5.00 land, with annual taxes figured at both $0.10 and $0.20 per acre.

cost of taxes will be greater, if the rotation is long enough, than the cost of land plus interest.

In general, the greater the value of land, the higher it is taxed; hence, it is doubly important to use low-priced land for forestry. The

general problem of forest taxation and the various taxation methods designed to lighten the tax burden on forest lands are discussed in Chapter XVII.

Neither the sale price nor the taxes on a piece of land are necessarily based on its suitability or value for forest production. In valu-

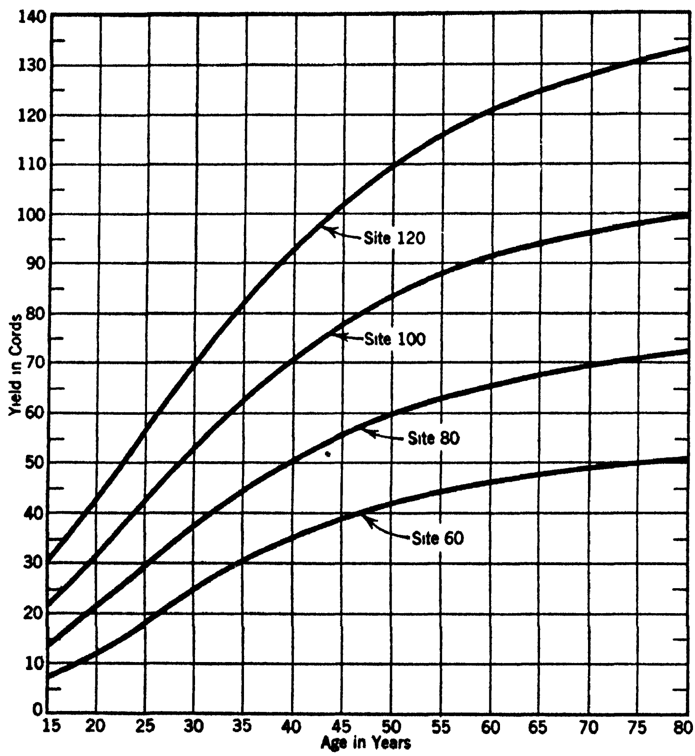

Fig. 44. Yield per acre in cords of fully stocked loblolly pine stands at various ages for the highest, lowest, and two intermediate site classes. [From *Volume, Yield and Stand Tables for Second-Growth Southern Pines,* Table 46. Miscellaneous Publication 50, United States Department of Agriculture, 1929.]

ing land for forestry, therefore, the first essential is to determine its producing capacity. If this is high, it may justify a high price and tax rate; if low, it may not justify even a low purchase price and tax rate.

Forest soils are classified in groups, technically called *sites,* based on their determined capacity for the production of given species or groups of species. The results are embodied in *yield tables,* which give the volume of usable material produced by even-aged stands of full density at different ages. The number of sites varies from 3 to

7 or more. Their designation may be numerical, as sites 1, 2, 3, the best site usually being given the lowest number; or the designation may be by a *site index,* determined by the height of average dominant trees in the stand. In such a site classification the lowest number represents the poorest site.[1]

Figure 44 shows the yield at different ages of even-aged, full-density stands of loblolly pine in 4 of 7 site classes, including the highest and the lowest. The enormous variation in the productivity by sites is apparent, the yield for the best site nearly three times that of the poorest at all ages up to maturity. It takes little imagination to see that site 120 land should be worth almost three times as much for growing loblolly pine pulpwood as site 60 land.

This tells us nothing about the monetary value of any of these sites for growing pine or for other uses, but the determination of the productive capacity of a piece of land is the first step in its monetary valuation. In the absence of yield tables, comparative current-annual growth studies may serve, to some extent, the purpose of rating productive capacity.

6. THE VALUATION OF LANDS FOR FOREST PRODUCTION

A. Soil Value. Foresters need a method of monetary valuation of lands in terms of their timber-producing capacity. This value is known as *forest soil* value,[2] can be derived from an estimate of the future profit from its use, discounted to the present. *Soil value, therefore, is the capitalized value of the soil for growing timber.* It has nothing to do with the value of the timber, mature or immature, on the land at the time, which must be added to that of the soil if a valuation of the entire property is required (Chapt. XVIII). Similarly, with the purchase of a cotton field when the cotton is ready for picking, the purchaser must pay for both field and crop, but the value of the field for producing cotton is the same before and after picking.

Forest soil valuation is a summation of five processes.

1. A determination of the physical quality of the land for tree growth (Sec. 5).
2. An estimate of the cost of producing a crop on the land in question (Chapt. XIV, Sec. 10).

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[1] For full discussion of yield tables see Chapman and Demeritt, *Forest Mensuration,* Chapts. XXII and XXIII, 1936; and Bruce and Shumaker, *Forest Mensuration,* Chapt. XXIV, 1937.

[2] Also called *soil rent* value, *soil expectation* value, or simply *soil* value.

3. An estimate of its sale value at maturity (Chapt. XVIII, Sec. 4).

4. An estimate of the net profit from its sale (Item 3 minus Item 2).

5. A determination from Item 4 of the present or capital value of the land by discounting future net income to the present (Chapt. VI, Sec. 8*I*, and Chapt. VIII, Sec. 1*B*).

We can best illustrate this process by a sample case, omitting Step 2, the calculation of production costs,[1] and Step 3, the estimate of the sale value of the crop, and by assuming a certain profit (Step 4).

Utilizing the figures from the yield table from which Fig. 44 was graphed, let us determine the soil value of sites 120 and 60 for growing loblolly pulpwood on a 30-year rotation by making the assumption that a net profit of $1.00 per cord per acre per rotation may be obtained. Since site 120 yields 70 cords and site 60 yields 25 cords, the net profit on site 120 will be $70 and, on site 60, $25. Their present values are determined by the compound-discount formula [$V_0 = V_n/1.0p^n$ (Formula 5)].[2] At 3 percent (Chapt. VI, Sec. 4) their present values are

$$\text{Site 120:} \qquad V_0 = \frac{70}{1.03^{30}} = \frac{70}{2.4273} = \$28.84$$

$$\text{Site 60:} \qquad V_0 = \frac{25}{1.03^{30}} = \frac{25}{2.4273} = \$10.30$$

This sets the soil values for growing a crop of pulpwood on each of the sites on a rotation of 30 years. Handled under forestry methods, they will grow crops every 30 years, presumably forever. The present values of the second crops are determined by discounting $70 and $25 by 60 years, the third by 90 years, and so on. Following are their values.

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[1] The question is bound to be raised, whether the cost of the land itself is included in production costs. If the land is being valued for its producing capacity, the answer is no. The case is similar to a stumpage valuation (Chapt. XVIII, Sec. 2) where the price to be paid is the x of the equation. Here the value of the soil is the x. The case is one of determining a *use*, not a *cost*, value (Chapt. VIII, Sec. 1*B*). If the land cost is included, we are determining the possibility of profit on an investment of a certain sum in land for growing forests, which is another matter (Chapt. XIV, Sec. 13). However, the soil-value calculation can be made for land already owned to determine its use value for comparison with other land or for book-valuation purposes (Secs. *C* and *D*).

[2] *SV* (or S_e) = Soil value is sometimes used here in place of V_0.

Years Discounted	*Site 120*	*Site 60*
30	$28.84	$10.30
60	11.88	4.25
90	4.90	1.75
120	2.02	0.72

Figure 45 diagrams these values for site 120. A site 60 diagram would be similar but with lower values throughout. It will be ob-

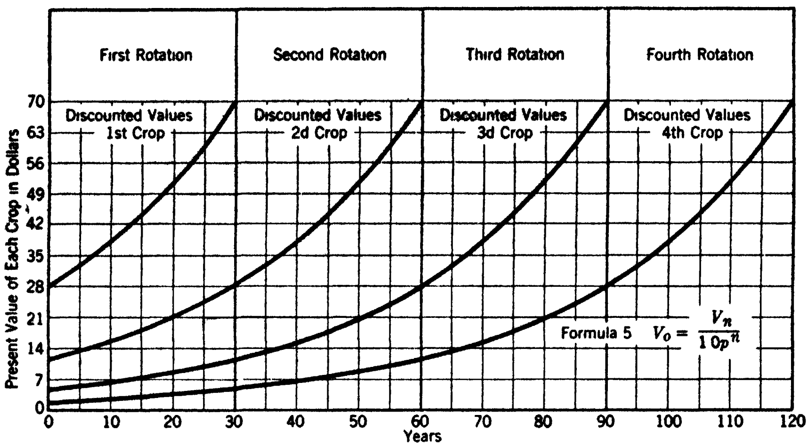

FIG. 45. Present value of four crops of pulpwood to be grown successively on the same acre. Each is assumed to have a net value of $70 at maturity and is discounted at 3%. Their total net value at the start of the first rotation is the sum of their individual discounted values at that time, totaling $48.73.

served that the present value of the crops decreases progressively as they mature at more distant periods, but the value of the land increases with the number of crops grown, as is shown by the following tabulation.

Number of Crops	*Site 120*	*Site 60*
First crop	$28.84	$10.30
First 2 crops	40.72	14.55
First 3 crops	45.62	16.30
All 4 crops	47.64	17.02

We have now established a soil value of $47.64 for growing 4 crops of loblolly pulpwood under the conditions stated above.[1]

[1] It is possible to combine the compound-discount formula [(Formula 5) $V_0 = V_n/1.0p^n$], used for each of these calculations, into a series as follows:

If we desire to go beyond this point in the calculation, we should carry it, as the mathematicians say, to infinity by the use of the formula

$$V_0 = \frac{PR}{(1.0p)^m - 1}$$ [*Formula 13—Present Value of an Infinite Series of Periodic Payments*]

PR is periodic rental or value of each crop and the interval between crops *m*. The calculation for site 120 then becomes:

$$V_0 = \frac{70}{1.0p^{30} - 1} = \frac{70}{2.4273 - 1} = \frac{70}{1.4273} = \$49.04$$

This \$49.04 is the soil value of site 120 loblolly pineland for growing pulpwood on a 30-year rotation at an estimated net value of \$1.00 per cord at the end of the rotation, arrived at on the assumption that the process continued forever. It is observed that carrying the computation to infinity adds only about \$1.50 to the soil value as determined for the first 4 rotations. Since the calculation is simple, it is generally used in the determination of soil value if more than one rotation is considered. This value, so determined, is supposedly what one could afford to pay for forest land to grow a given product on a

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$$V_0 = \frac{PR}{1.0p^n} + \frac{PR}{1.0p^{2n}} + \frac{PR}{1.0p^{3n}} + \frac{PR}{1.0p^{4n}} \cdots$$

for as many crops or rotations as desired. This omnibus formula reduces to

$$V_0 = \frac{PR(1.0p^{mn} - 1)}{(1.0p^m - 1)^{1.0p^{mn}}}$$ [*Formula 12—Present Value of a Terminating Series of Periodic Rentals*]

In it PR = periodic rental and m the time between crops and n the number of crops. The solution gives the soil value for the number of crops to be figured in one calculation. Thus for site 120:

$$PR = 70,\ 1.0p = 1.03,\ m = 30, \text{ and } n = 4$$

Substituting:

$$V_0 = \frac{70(1.03^{30 \times 4} - 1)}{(1.03^{30} - 1)^{1.03^{30 \times 4}}} = \frac{70(1.03^{120} - 1)}{(1.03^{30} - 1)^{1.03^{120}}}$$

$$= \frac{70(34.71 - 1)}{(2.427 - 1)^{34.71}} = \frac{70 \times 33.71}{1.427 \times 34.71} = \frac{2359.70}{49.531} = \$47.64$$

If only a few rotations are to be calculated, it may be quicker to figure them individually, as was done above.

given rotation, *the profit coming from the net value of all the future crops which are bought at a discount.*

However, there are a number of things it is necessary to grasp regarding soil value before its practical significance can be understood.

1. The figures presented above would have no validity in determining the value of the land for the production of hardwood pulpwood, or even for loblolly pine lumber, because the yields, costs, and prices would all be different.
2. The value obtained will be different for different length of rotation or rate of interest, all other elements remaining the same.
3. Since table figures for maximum yield can never be realized in large-scale practice, a liberal allowance must be made to cover the discrepancy.
4. Even then the results are accurate only if the figures put into the formula are themselves accurate. And who knows what pulpwood will sell for in the year 2060?
5. Lastly, even if an accurate soil value determination has been obtained, what assurance is there that the prospective investor can buy the lands so valued at this price, or, if he already owns them, that he did not pay more for them?

The reader may then ask, "Why bother with it anyway?" In spite of its limitations, it has three sorts of uses: (1) as a means of comparing different lands as to their relative value for forestry and of comparing the results of different treatments on the same land; (2) as a means of getting some sort of check on prices asked for land; and (3) as a means of setting a book-account value to lands.

In comparative valuations it is necessary to use the same discount rate. Any rate will do, as all will give the same ratio of value between the types of land or treatment. Three percent is usually employed, for it generally is in book valuation (Chapt. VI, Sec. 4). In trying to gain an insight into purchase value, the rate at which capital may be borrowed for the enterprise must be used.

B. Soil Value As a Means of Comparison. We illustrated the use of soil value as a means of comparison between sites 60 and 120 (pp. 268–270). For this purpose it does not matter greatly whether the estimated profits later prove correct, as the relative value of the two site classes remains the same.[1]

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[1] In dealing with pulpwood, which is seldom graded or sold by size of stick, the same unit sale price will prevail for all sites producing the same or a closely related species, so that the price ratio takes care of itself. When dealing with

We can also compare the financial advantage from the use of different species, methods of treatment, and lengths of rotations on the same-quality land, thus answering such questions as: Which will utilize the soil in the pulpwood region of Maine to the highest financial advantage, quick-growing but lower-valued balsam or higher-valued but slower-growing spruce? It takes a longer rotation to grow slash pine lumber than pulpwood of the same species in the southern pine region, but the lumber is worth more. Which will justify paying the higher price for the land? If we assume that the ratio of value of spruce and balsam pulpwood, on the one hand, and slash pine lumber and pulpwood, on the other, will remain substantially the same, the soil-valuation formula will give the answer.

C. Soil Value As a Check on Land Prices. The average forest owner generally has little idea of the producing value of his land and often considers it worth more than it actually is. The calculations of future-use value and its discount to the present is common in all sorts of land-valuation problems. Nobody expects them to be 100 percent accurate, any more than are other calculations dealing with future values, but intelligently utilized, they are better than blind guessing. Once a calculation of soil value has been made, the prospective purchaser or seller of forest land has at least a basis for bargaining.

The fact that no one has any idea of prices in the distant future need not be disturbing, for it is evident from the tabulation on page 269 that the bulk of the value comes in the first rotation. (The soil value of site 120 was $47.64, of which $28.84 pertained to the first crop.) It must be admitted that in dealing with huge areas of denuded land, where we have very little idea of future-growth rates, yields, lengths of rotation, or costs of production, soil-value calculations are little improvement over guessing.

As time goes on and more and better growth data is assembled and more and more forestry practiced, it should be no surprise if soil-value calculations become the accepted basis for the sale and purchase of forest lands; after all, the essential value of land is the value of its products.

D. Soil Value for Determination of Book Value. It is often useful to assign a book value to land or other property, based on estimated earning power without reference to its purchase price. This is as true in forestry as in other businesses. The use of soil value is frequently logical under such circumstances. The value so obtained has

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lumber, the grades will differ on the different sites, and we cannot safely apply the same price per thousand feet board measure to both (Chapts. X and XVIII).

all sorts of uses, one example of which is to value lands already owned for other purposes, on which forestry is to be practiced as a subsidiary enterprise. Suppose a water company owns watershed lands for which it had to pay $100 an acre. Forestry probably would not be profitable with land at that price, but if a soil value calculation showed it to be worth $15 per acre for forestry, it then becomes possible to make a proper accounting of forestry operations on a basis of $15 land.

E. Soil Value in Sustained-Yield Forests. We have so far discussed soil value only in terms of even-aged stands, cut at a definite rotation age. It is both more difficult and not often necessary to value a forest producing an annual income by this method. We can value such a forest by the same method used for a house or for any other annual-income-producing property simply by capitalizing its average annual net income (Chapt. VI, Sec. *7B*); namely, by choosing an appropriate interest rate and by dividing it into the income [(Formula 8) $V_0 = AR/0.0p$]. Thus, a sustained-yield forest produces an income of $25 per acre with interest at 5 percent, its capital value per acre would be $500.

It is obvious that this method has the practical advantage of setting a value on the property as a whole, based on its earning capacity, and can be used also to set comparative values between different sustained-yield properties. Nevertheless, it does not value the soil separately, and therefore it is a forest rather than a soil value.

7. THEORIES REGARDING CALCULATIONS OF FOREST EARNINGS

There are two different theories as to the place of land in the calculation of earnings in forestry. While some of the discussion, which has gone on for over a century, regarding them is somewhat doctrinaire, each has certain practical aspects, notably in the setting of the length of rotation and in the treatment of the interest problem. They are discussed in later chapters. All that is attempted here is to outline the theories as they relate to the other material in this chapter.

The first theory is known as *soil rent.* It assumes that the soil is the basic capital of a forestry enterprise and that the tree growth is the interest derived from the use of the soil. Or, to put it another way, the soil is the factory and the timber is its product, all the earnings of the enterprise being derived from the use of the land.[1] The

[1] The single tax theory of Henry George is a larger application of the same idea; namely, that all profits stem from the use of land. Henry George, *Progress and Poverty,* D. Appleton Century Company, New York, 1879.

second theory is known as *forest rent.* It assumes that the land and tree growth jointly form the capital of the enterprise; that they are, so to speak, one property from which an income is derived and that their value need not be separated.

Regardless of the theoretical merits of either theory, it is obvious from the previous section that when one is valuing bare or practically bare land it is necessary to use the soil-rent theory, for, as we saw in the first part of Section 6*A*, we can fix the value of the land only in terms of what it will produce in forest products. However, when we are dealing with a producing forest, as was seen in the last part of Section 6*E*, for most purposes the determination together of the value of the land and growing stock was much simpler and usually was adequate. In other words, we unwittingly used the forest-rent theory that land and tree growth must be considered together, that they jointly produce the profit from the enterprise.

8. FOREST-LAND ACQUISITION

The selection and purchase of lands for forestry involves not only the question of valuation discussed above but also questions relating to actual purchase operations and policies. It is seldom that a forest suitable in area, location, and age-class distribution can be bought in one transaction; it must be built up in a series of separate purchases over a long period of years. Generally speaking, the more it is hastened, the more it costs. The cost and complexity of large purchase programs, public and private, are outlined below.

A. Acquisition Costs. The total cost of a piece of land includes the sum paid the previous owner for it, plus the cost to the purchaser for investigations involved. This investigation cost adds appreciably to the purchase price. It covers surveys, appraisals, title searches, clearance, and registrations, time spent in bargaining with owners, and the overhead costs of the acquisition staff. This work calls for men of widely divergent capacities, including administrators, foresters, engineers, appraisers, and lawyers. Its expense has no fixed relation to size or value of the area, nor can it be standardized except perhaps for the cost of an appraisal made on the basis of a timber-cruise and a site-class determination. However, it is related to the number of parcels purchased because the larger the number and the smaller their size, the more work is required to locate them and their owners, check titles, bargain, and the like. Any relation to the value of the area is likely to be an inverse one since the less value is attached to a piece of land, the less care the owner usually takes to mark its boundaries

and insure that its title is unclouded by mortgages, unpaid taxes, or conflicting deeds. Such costs sometimes may exceed the actual purchase price of small low-value parcels, particularly if legal proceedings are required to settle questions of title. When it becomes evident that these costs are going to be high in relation to the value of a piece of land, the prospective purchaser may go no further.

Acquisition costs usually are lowest in regions having definite survey or title registration systems, such as in the public land states.[1] They must be added to purchase price either by prorating them on an acreage basis or by adding the cost of each area to its actual purchase price. The cost of investigating land not purchased must be added to that which is purchased, in order to get a true cost picture for the purchase area (Sec. 8*D*). In discussing land costs, it is assumed that acquisition cost is included in the term "land cost."

B. "The Price of Land." Two pieces of land seldom have the same value. Nevertheless, at any given time prices in any region have a tendency to stabilize and become fixed for lands of the same general nature. Thus, in a farm region, plow land may be considered worth $25 an acre and cutover land $3.00. In sales transactions these prices serve as starting points for negotiation, the prices agreed upon being above or below them, depending upon circumstances.

In regions where real estate transactions are infrequent, prices often remain fixed for many years, perhaps long after they cease to have any relation to earning power of the land. However, any attempt to purchase such lands in quantity will raise this price level. A price of $3.00 may become nominal for cutover land because no one has wanted to buy it. At this price, its purchase for forestry may be justified, but a buyer can seldom obtain many tracts at this price because as soon as he starts operations he creates a demand and, as the saying goes, "raises the price against himself," possibly to a point above the

[1] Acquisition costs on the national forests may be roughly gauged from the statement ". . . such cost of appropriations and allotments for national forests aggregating $82,586,580.48, 80.48 percent actually has been disbursed or obligated in actual payment for lands, and 19.52 percent expended on activities incident to the purchase of lands." (Letter to the writer from R. F. Hammatt, Assistant to the Chief, United States Forest Service, dated January 21, 1941.)

As to state forests, Austin F. Hawes, State Forester of Connecticut, writes (Apr. 15, 1940), "For the five-year period July 1, 1925 to June 30, 1930 . . . the Commission acquired 42,217 acres and the costs of acquisition; that is, for salaries and expenses, amounted to $39,547.81, an average of 94¢ per acre. This does not include surveying and typing" [that is, type mapping] "which I think is about another dollar per acre."

profit margin. Therefore, he must either make his purchases slowly over a long period and in more or less isolated tracts, in order not to appear to be creating a demand, or he must determine the maximum he can afford to pay, announce publicly his intention of not exceeding that price, and wait until owners are ready to sell.

Perhaps it is easier for a public than for a private agency to follow the latter course, but in a region where there is little or no competition from other purchasers, the second course is often possible for a private agency once it has secured enough land to launch its enterprise in the initial stage. If competition forces prices too high, results may be disastrous to all concerned because prospective buyers may have to abandon their projects and those holding the lands may be left without a market.

C. Timbered versus Cutover or Bare Land. Agencies that are building up forest areas must decide whether to buy primarily cutover or abandoned agricultural land, or land already timbered, or to buy some of both. Assuming an average soil value of $4.00 per acre and a stumpage value of $3.00 per thousand feet, it is obvious that a timbered tract of even as low a yield as 5000 feet per acre will cost about seven times as much as bare land. Therefore, the decision has great influence on area that can be purchased on a given budget.

In private acquisition the question is an economic one, hinging on the relative financial advantage under the particular circumstances of (1) a small investment and a long wait for returns on it or (2) a greater investment and an earlier return (Chapt. X, Sec. 7). In public acquisition the question is one of public policy, whether to acquire a larger area for its future public benefits from reforestation or to conserve a smaller area which, if cutover destructively, would be a public loss.

Regardless of its possible merits as an investment (Chapt. XIX, Sec. 4*D*) it is impossible to establish an immediate business in forestry by buying bare land and reforesting it artificially or expecting nature to do so, knowing that no return is possible for at least 30 years and possibly twice that length of time. On the other hand, the purchase of a large area of mature timber may require an investment that must be liquidated in a relatively short time to forestall excessive carrying charges. Obviously, the sensible course is a middle one, in which the total area purchased has an approximately equal distribution of age classes, so that some timber can be harvested at once, the timber on other areas can be allowed to mature as needed, and the

bare land can be brought into production last. The difficulty is to find such areas either in one tract or many.

This method is equally sound for public acquisition when the objective is to set up a public business in producing timber, but this is seldom the only objective even when there are no protective, recreational, or wildlife factors in the program. Usually the primary objective is to provide an economic use for cutover or degraded forest or for abandoned and worn-out agricultural land in regions where such lands are abundant and there is no apparent use for them in private ownership. Under these conditions the bulk of the lands will be either barren of tree growth or in the very young age classes. However, there usually are some mature or merchantable timber tracts scattered about in the lands, and there are always those who advocate purchase to prevent destruction of these tracts by private interests. Since such areas are often held at inflated values from the long-range point of view, it would be better to purchase a larger area of denuded lands and start its reconstruction. However, sometimes it may be wise to buy these occasional tracts because they have a recreational or scientific value and are popular with the public. The economic aspect of acquisition, as applied to protection, recreational, and wildlife forests, is discussed in Chapter XVI.

Both private and public agencies sometimes too speedily liquidate all the merchantable timber acquired during the acquisition stage of their enterprise, with the idea of proving that forestry is profitable or with the purpose of expending the profit for improvements or further acquisitions, thus forcing a discontinuance of their enterprise for many years.

D. Purchase Areas. If lands are well blocked up, the costs of administration, protection, and product transportation may be kept at a minimum. On the other hand, the necessities of purchasing lands at suitable prices and at times when owners will sell usually precludes immediate acquisition of well-blocked-up areas of good age-class distribution and of the best site classes.

Usually the solution is to decide upon a purchase area that is somewhat larger than actually necessary and to make purchases within it as funds are available and as owners are willing to sell at reasonable prices, buying the most desirable land first as far as possible.

Certain land lying within a large purchase area may not be suited to economic forestry. There may be some good agricultural land as well as some forest land of very low site classes, or some not capable of producing the kind of timber desired. It is often impossible to

avoid purchasing some land that is not suited to the enterprise in order to secure what is needed. This is particularly true in forest land of poor site classes. An owner frequently will balk at selling only his good land. The loss entailed from purchase and carrying charges on such unsuitable lands must be regarded in the same light as losses of a similar nature which occur in all business enterprises—none can be 100 percent efficient.

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CHAPTER XIV

COSTS AND PROFITS IN FORESTRY

In business, costs appear as items on books kept as operations proceed. Upon the basis of these records, plus other data, estimates are made of future costs in order to plan future operations and to decide on the possible financial advantages of different expenditures and policies. In America, forestry has not been carried on long enough to afford much exact cost data; consequently, estimates are not too reliable. This should serve to encourage the study of the nature of these costs and of the accounting methods involved in their handling.

The cost items in forestry are

1. Land.
2. Engineering improvements.
3. Administration.
4. Stand establishment.
5. Stand improvement.
6. Protection.
7. Taxes.
8. Insurance.
9. Interest.

Most of these costs involve investment and operating, overhead and direct items (Chapt. VIII, Sec. 2). Since land costs were considered in Chapter XIII, little further reference to it is required. Furthermore, the material in this chapter applies only to the production of wood crops; costs in other types of forestry are discussed in Chapter XVI. Although the cost factors in timber-production forestry are the same in both public and private forestry, certain minor differences are pointed out in this chapter and in Chapter XX, Section 6. The discussion of profits (Sec. 13) is concerned here only with methods of calculation; questions of possibilities are deferred to Chapter XIX.

1. ECONOMICS VERSUS SILVICULTURE

In the industrial processes (Chapt. VIII, Sec. 2*E*) the law of diminishing returns in the application of capital and labor increases costs

after a certain point is reached. It is characteristic of the forester, as of all technicians engaged in the production of goods, that he desires to work for the highest attainable output of the highest possible quality.[1] Nevertheless, it is a necessity of private business that production and quality be obtained within the limits of selling price (Chapt. VIII, Sec. 3). If to do so it is necessary to reduce output and to lower quality, it must be done. Public business usually has a similar limitation in that both public opinion and authority are usually unwilling to sanction expenditures that are sufficient to obtain maximum production and quality even when the profit motive, financial or even social, is not an issue.

The silviculturist and those charged with financial management, even if themselves foresters, seldom see costs in quite the same light. The silviculturist will wish to expend large sums to obtain maximum production by thinning early and often, to leave enough seed trees to be absolutely sure of adequate reproduction, and so on. He will desire to increase capital expenditures in roads, fire-protection works, and equipment to make more nearly perfect his silviculture and protective operations. Given the opportunity, he will tend to ignore the factor of diminishing economic returns. Those in charge of finances will have to ask questions such as: Will the cost of an early thinning which produces no salable products increase the final yield more than enough to pay the cost of the operation plus carrying charges? Assuming that 10 immediately salable seed trees will seed up an acre in 5 years, would it not be better to turn 5 trees into money now and trust that the other 5 will do the job in 10 years? Will the cost of building and maintaining a fire-protection road reduce protection cost enough to justify it? How does its cost of construction compare with the maturity value of the timber to be protected?

In the arguments resulting, too few facts are available. Seldom does the silviculturist know even in quantities how much he can increase production by a given expenditure. Never does the management know what future values will be. Time should improve the position of the silviculturist. Studies of the quantitative results of different silvicultural treatments are being made, which, as they become available, will help, as will time studies of costs of various silvicultural operations. Management, short of operating in a completely stabilized economic system, will never know future values, but, since no investment is without risk, it must be willing to take at least the minimum

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[1] Thorstein Veblen, *The Instinct of Workmanship and the State of the Industrial Arts*, The Macmillan Company, New York, 1914.

of chances that investment to increase production will result in a profit. If no such chances are taken, no investments in forestry or anything else will be made (Chapt. V, Sec. 4), but the amount invested must have some relation to the probable profit. Even on land where forestry is economically possible (Chapt. XIII, Sec. 4), not all forests will justify the same expenditure; so it must be practiced with varying degrees of intensity.

FORESTRY—INTENSIVE AND EXTENSIVE

Forestry may be practiced on either an *intensive* or an *extensive* basis. The first basis assumes that a large investment in silviculture, protection, and improvements, resulting in a larger crop in a shorter time, will pay for itself. Extensive forestry assumes the contrary, namely that a large investment will not increase the final profit even though it does the final yield. Intensive forestry, carried to its highest degree, involves an elaborate system of engineering improvement and the frequent use of cultural measures. Extensive forestry in the simplest form is hardly more than fire protection plus some inexpensive method of securing reproduction.

The form of the forest and the degree of the demand for its products are the determining factors in judging the relative economic advantages of the two types Forests where growth is slow, marginal species numerous, and stumpage values low must be managed on an extensive basis. In regions of rapid growth, few marginal species, and high stumpage values, practice may be intensive. Generally speaking, the most intensive forestry is practiced in regions where the pressure of demand on the forest is so great that even the smallest trees and poorest species are above marginal limits.[1] With the exception of certain physically and economically favored localities, American forestry must be on a more or less extensive basis until there is a demand for the large quantities of low-grade material which can be obtained from cultural measures designed to increase the value of the final harvest.

Forestry of the same degree of intensity seldom can be practiced on all parts of a forest, the reason being that neither types nor site classes (Fig. 44) are uniform except over small areas. The resulting

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[1] An illustration of an extreme instance of intensive forestry: In 1919 the writer was called upon to estimate the damage to a 10-year-old plantation in Germany, accidentally burned by soldiers of the Allied Army of Occupation. All the trees were killed outright. Twenty-four hours after the fire they had all been cut and sold to local inhabitants for firewood and removed, and 48 hours later the area was replanted.

differences in productivity determine the intensity of management. In mountainous regions north and lower slopes will justify more intensive silviculture than south and upper slopes. At present prices, more intensive forestry can be practiced on pine flats than in the hardwood swamps of the South. A shift in the value of the species involved would reverse the relations.

3. FOREST COST ACCOUNTING

Forest cost accounting is based on keeping the total and unit cost of producing a crop of timber from its establishment to harvest. The latter cost (Chapt. X) is not included although naturally it figures in the cost chain from seedling to final product. If a single, even-aged stand were established as the sole basis of a forestry enterprise, one set of books would be kept from seeding until harvest. If a forest consists of a series of even-aged stands, one established every time one is harvested, it is necessary, if records are to be complete, to have a set of books for each. If the forest is a selection forest, uniform throughout, one set of accounts might do, although this probably would never occur in practice, and some more detailed method would be necessary. Therefore, it is frequently necessary to set up somewhat arbitrary units of area for cost keeping.[1]

Cost data must be in terms of both area and volume; as acre, hectare, or quarter section, on the one hand, and cord, thousand feet, or number of piece products, on the other. Area units are necessary to figure the returns on the investment of a given sum in land and engineering improvements thereto (Sec. 4). Volume units are required in order to determine the production cost per unit of product. Most costs are more easily kept or estimated in area units. Planting costs in acres are known as soon as the job is finished; their cost in terms of volume of product can be known only when the stand is harvested, but by use of yield tables and other cost estimates it may be forecast as soon as the acreage cost is known. Likewise, other costs on an area or linear base, as cost per mile of telephone line, must be converted into cost per unit of final product. With companies that manufacture raw forest products into final form, costs must be further converted into the ultimate sales unit (Chapt. VIII, Sec. 2*C*).

In forest operations some revenue may be derived from the rental of camping, hunting, or fishing privileges, which may be kept separate or treated as reducing costs of timber production (Sec. 10). If they

[1] Discussion of such units belongs in texts on forest management.

are small and quite incidental, it is better to treat them as reducing costs. If the business of supplying these services is large, it should stand on its own feet. Revenue may be derived from the sale of improvement cuttings. Usually this is treated as reducing the cost of production of the final crop (Sec. 10).

4. ENGINEERING IMPROVEMENTS

The administration, management, protection, improvement, and harvesting of products of a forest of any size demand the construction and maintenance of a rather permanent network of roads, trails, telephone lines, the building of ranger stations, fire towers, sometimes firebreaks, and occasionally other constructions. All these, for lack of a better term, may be called *engineering* or *land improvements*. They do not include temporary roads, camps, and similar construction used for logging a single crop of timber and then abandoned. These improvements must be paid from the proceeds of the crop (Chapt. X, Sec. 3). Engineering improvements, being of permanent nature even though some must be renewed periodically, in theory can be paid from the proceeds of as many crops as their life is long (Chapt. XIII, Sec. 1). However, it is better to amortize them as soon as earnings permit (Chapt. VII, Sec. 6). Their cost, therefore, is usually added to that of the land and treated as a permanent investment, and their upkeep is treated as an annual charge on operations. Thus a permanent road, costing $5000 on a 1000-acre forest, adds $5.00 per acre to the land investment. The importance and cost of forest-engineering works frequently is overlooked. A large and well-developed forest requires a considerable capital investment in such improvements, particularly when situated in a remote and unsettled region where public roads and telephone systems may be non-existent.

On large public or private forests it may be unnecessary to charge the entire cost of road construction and maintenance against timber production, either because the roads have other uses which legitimately should bear some of their costs or because they produce a certain amount of revenue. Most roads on public forests bear some recreational traffic. Some roads are constructed exclusively for such use. Intensively used recreational roads are more expensive to construct and generally require more maintenance than purely forest roads. To charge their entire cost against timber production is poor accounting. A proper prorating of these costs between forestry and recreation may be difficult but it is justified. Obviously, the cost of construction, operation, and maintenance of purely recreational works, such as over-

night cabins and bathing facilities, should not be charged against timber production. For minor picnic areas whose construction and operations cost is small, a separate accounting may not be worth while. Occasionally forest improvements may produce incidental revenue. A government-owned telephone system on a large forest may serve private subscribers living on or near it. A paper company may build a system of roads for its own use in an area where public roads are non-existent and open them to public use on a toll basis.

The permanent road system on a forest may be constructed with the intention of using it solely for protection and administrative purposes, the removal of timber being accomplished over temporary roads as needed, or the permanent road system may be built with the intention of taking care of both uses. On smaller and more intensively managed forests where thinnings are frequent and the volume of timber to be removed at any one time is small, a permanent road system is better. Where the interval between cuts is long, the cost of maintenance of a system of logging roads for perhaps half a century, during which it is not used, is so great that it is more economical to rebuild it entirely when again needed. In doubtful cases comparison between costs of maintenance and costs of new construction should be made. The calculations necessary are to figure the maintenance cost (annual plus interest) required to keep the roads in operation and to compare its discounted value with that of the cost of building a new system when the time comes.

It is obvious that engineering improvements represent an investment cost which, although charged against the land, could be charged against all or against special forestry operations. The road system is partly used for protection, partly for stand establishment and improvement, partly for harvesting—if it includes permanent logging roads—but a lookout tower is chargeable entirely to fire protection.

The factors regarding size of investment in engineering improvements are the same as for all investments that are made to reduce production cost. The more the investment is increased, the lower operating costs and the higher indirect costs become, until finally the increase in investment results in an increase in production cost (Chapt. VIII, Sec. 2*C*). A forest can have, as do most forests, too few roads, but it can also have too many, just as a logging railway can be too well built for the footage of logs to be carried.

It is seldom financially possible to build all the improvements that eventually will be needed when a forest is first put under management; nor is it always necessary. The building of engineering improve-

ments, like any other form of investment, can be financed by borrowing or by reinvestment of earnings.

5. ADMINISTRATIVE COSTS

The administration costs of a forest are naturally those of general supervision of all forest operations, including activities other than those pertaining to timber production as may be carried on. In an estimation of costs of timber production, the cost of administrative activities, for instance, supervision of forest recreation, should be eliminated. All the administrative costs of silvicultural operations frequently are merged with protective costs. A better cost picture can be obtained if they are kept separate. Finally, all justifiable administrative costs are prorated on an area and volume basis.

6. STAND ESTABLISHMENT

This includes the cost of obtaining reproduction whether by artificial or natural means. In the first case it is the cost of direct seeding or planting, including if necessary the cost of preparing the site by cutting brush or the cost of similar tasks; in the second case it is the added cost of logging that is necessary to provide for reproduction, plus the cost of leaving such merchantable seed trees as are required (Chapt. X, Sec. 7). If the trees so left are salvageable when they have accomplished their function, proper deduction must be made in accounting so that the cost of establishment is not made to seem greater than it actually is.

The determination of the cost of seeding and planting on a per tree or per acre basis affords few accounting difficulties; it was taken up in Sec. 3. Costs of securing natural reproduction are more difficult to compute when it is secured as a result of two or more partial cuttings or when a seed-tree system is used. A simple case will illustrate the principles involved. Assume a stand to be clear cut in one operation and seed trees left. They are mature and can be salvaged in 15 years, when it is expected that the new stand will be fully established. The extra cost of logging consists only of brush disposal, half of which can be charged to fire protection. Since the seed trees can be salvaged, they are a charge against the new crop only in so far as their value changes during the period they remain standing. If they are comparatively young and vigorous their value will probably increase—perhaps enough to wipe out the cost of leaving them. If they cannot be salvaged until the new stand is ready for a cutting, they usually represent a loss because, even if they are still sound, they will prob-

ably have passed the age of financial maturity (Sec. 12). With partial cutting to open up a stand so that a new crop can start, the value of that portion of the timber left must be compared to its value when it is removed later in order to measure the cost of stand establishment (Chapt. XVIII, Secs. 4 and 5).

7. SILVICULTURAL IMPROVEMENTS

Forestry recognizes the desirability of making cuttings in a stand at various times during its life for the purpose of increasing its final yield. These operations are known as thinnings, improvement cuttings, or cultural operations.[1] They fall into the following economic groups.

Group 1—those operations where the material removed has no sale value, therefore the entire cost is an investment which can only be realized on when the stand that has been improved is finally harvested, recovery of the investment coming from increased volume and quality of the final crop. Weedings in very young stands and wolf tree removals in those somewhat older are examples.

Group 2—those operations where the material cut has too little sale value to meet the cost of its removal. This simply reduces, sometimes materially, sometimes scarcely at all, the cost of the operation. Cordwood thinnings, consisting of inferior species or of trees of small size, where the cordage obtained is small, usually fall into this group.

Group 3—those operations where the sale of material removed more than meets the cost of removal. In other words, it yields an operating profit. Thinnings in older age classes where the amount, size, and quality of material removed is high usually belong in this class.

In forest accounting the total loss in Group 1 and the net loss in Group 2 are treated as costs of production. The operating profit on the cuttings in Group 3 is treated as reducing the cost of production of the final crop (Sec. 10). Obviously, the higher the expected price of the unit of final product, the more the forester is justified in spending to increase the number of such units. Assume two stands of immature pulpwood, both of the same age and volume, one expected when mature to sell at $1.00, the other at $0.50 per cord. An early thinning which yields no salable material will increase final yield by 5 cords. At a total production of 90 cords per acre, the increase in sale value is $5.00 for the higher-value stand but only $2.50 for the lower-value one.

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[1] See textbooks on silviculture for a discussion of technics of these operations.

Generally speaking, the earlier in the life of a stand the cuttings are made, the more they increase the final yield in volume and quality, but the less likely they are to yield an operating profit or even to meet the immediate cost of operations. The economic as contrasted with the technical problem of the silviculturist is to determine the financial advantages of early as compared with later thinnings by balancing the increased costs of production for a more valuable crop against a lower cost of production for a less valuable one (Sec. 13).

8. PROTECTION

Forests must be protected from the hazards of fire, of insect, fungous, and other plant diseases, as well as from theft, grazing, and depredation of various kinds. The costs of protection are both *regular*, as for fire, insect, disease, and theft patrol, and *irregular*, as for fire fighting and the application of specific insect- and disease-control measures. The chief investment cost involved is in engineering improvements, as fire towers, telephone lines, fire lines, and stock fences. The control of insect pests and forest diseases usually does not require works of this nature.

Once the regular costs are known, they can be cared for by setting aside a regular sum annually to cover them and by properly prorating the sum on an area and volume basis. In most forests the occurrence of fires is to be expected despite all protective measures, but their number and severity cannot be foreseen. Consequently, the cost of suppression is an unknown quantity. After many years of record-keeping it may be possible to depend on the law of averages for cost estimation.[1] However, it is better to be liberal in making such estimates.

Serious attacks of certain insect pests and, to a lesser extent, of fungous diseases tend to be cyclic. Bark beetles and gypsy moths are examples of the former. Less is known about the latter. Infestations build up gradually and, if attacked in time, can often be controlled without great loss and at no great expense. Every so often new pests or diseases find their way from abroad into American forests and these are sometimes more dangerous than the native ones, and control sometimes proves impossible. The hazards are decreased by the growing efficiencies of public services charged with insect and plant pest control. The work of these agencies, both in its scientific and practical

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[1] With the exception of major conflagrations mentioned in Chapter XVIII, Section 13.

sides, is in effect an enormous subsidy for private forestry (Chapt. II, Sec. 4).

The costs of protection are in three categories.

1. *Pre-suppression costs.* These are investment costs, such as fire towers, and annual costs, such as silvicultural and stand-improvement work, designed to reduce fire, insect, and fungous hazards; annual or periodic costs of educational and research work, designed to minimize human hazards and to increase efficiency of control measures. All these expenditures have the nature of insurance costs in that they are not of themselves productive but are intended simply to prevent losses (Sec. 9).
2. *Actual costs* of fighting fires and applying insect- and disease-control measures.
3. *Post-suppression costs* of restoring the losses.

Salvage of fire-, fungous-, and insect-killed timber, when it is possible, may reduce these losses. Within reason, the greater the expenditures under Item 1, the less should be the costs of Items 2 and 3.

In estimates of costs of producing a stand of timber it is customary to lump all protection costs into one item notwithstanding how this general figure may be obtained. To have any validity it must include Items 1 and 2. Because Item 3, restoration of stands after a fire or other damage, is expensive, it is not likely to be carried beyond the salvage of material that is salable. The best method of handling Item 3 would be by insurance (Sec. 9) and by reducing the expected final yield by a percentage estimated sufficient to cover probable losses.

9. TAXES, INSURANCE, AND INTEREST

Little time need be spent discussing these costs here. The importance of land taxes was noted in Chapter XIII, Section 5, and is discussed further in Chapter XVII. Insurance is an overhead cost in all businesses that own physical property which may be destroyed when the risk of such destruction is low enough to justify an insurance company's accepting the risk. Insurance, for various reasons, is not customarily written on standing timber. There is evidence that it may be more commonly written in the future (Chapt. XVII, Sec. 13).

Other forms of insurance that concern forestry, besides what might be written on the crop, are those voluntarily written or carried according to law by employers for the protection of laborers against industrial accidents and loss of employment. Insurance on forest buildings and equipment may be carried also. Insurance is an annual charge,

as are taxes, and like all other charges may be prorated on an area or volume basis. Insurance costs for investments maturing in the future may be carried on the books, plus interest (Chapt. VI, Sec. 8*G*), under the same conditions as taxes or other annual charges of a similar nature.

The general nature of interest charges, the reason for their use, and the method of figuring them were discussed in Chapter VI. For the possible conditions under which they may be disregarded see Chapter XIX, Section 4*B*.

10. GROSS AND NET COST OF PRODUCING A TIMBER CROP

By *gross cost* is meant the entire expenditure, direct and indirect, of establishing, developing, and protecting an even-aged stand of timber to the rotation age (Sec. 12) at which it is to be harvested. The *net cost* is, of course, the total cost less any revenue derived during the process from thinnings or other sources which legitimately may be included.

Once the costs have been determined or estimated, the process is simple. For the gross cost, add the various costs, *including their carrying charges,* determined by use of the appropriate compound-interest formula, and *make the necessary deduction of remaining capital assets* (Sec. 10*A*). For the net cost deduct, in addition, incidental receipts (Sec. 10*B*). By remaining capital assets are meant the original cost of land plus the permanent improvements made on it (Sec. 3). The land is still an asset after the crop is harvested because it may be used to grow another crop, or may be devoted to other purposes, or may be sold. Improvements, likewise, unless they are destroyed or rendered useless because the land is to be used for other purposes, remain as assets. However, the carrying charges on both land and improvements are a necessary cost of production. They are, so to speak, rent for the use of the factory.

A. Gross Cost. Only two formulae are required for figuring carrying charges: [(Formula 2, Compound Interest), $V_n = V_0(1.0p^n)$] and [(Formula 6, Annuity), $V_n = AR(1.0p^n - 1/0.0p)$]. Formula 2 covers the cost and carrying charges which occur only once, such as land, stand establishment, and permanent improvements. Formula 6 covers taxes, protection, administration, and other annual expenses. When a complete cost breakdown is not required, calculation may be simplified as follows: (1) Total all the primary investment costs—land, improvements, and stand establishment—provided they are all made at the same time and carry the same interest rate, and figure the

interest charges in one operation. (2) Add annual cash cost of taxes, protection, administration, etc., to make a single annual rental item, and figure the amount of the resulting annuity. (3) Add Items 1 and 2. (4) Subtract the cash cost of land and improvements from Item 5, and obtain the gross cost of producing the crop. (Methods of deducting for incidental income to obtain net cost are discussed below.) This process is expressed in a formula by letting GC equal gross cost of production, II equal initial investment, and $(L + 1)$ equal cash cost of land plus improvements. Writing Formulae 2 and 6 in tandem formation, we obtain

$$GC = II(1.0p^n) + \frac{AR(1.0p^n - 1)}{0.0p} - (L + I)$$

[Formula 14—Gross Cost of Producing a Stand of Timber]

Formula 14, as given above, is in its simplest form. So written, it is valuable chiefly as showing principles involved. Aside from not giving a cost breakdown, it assumes many things that are not likely to happen in practice; that, for instance, the annual charges remain the same or do not change enough to affect the average (long-range averages do not work with compound interest); that the interest rate is not changed by refinancing or added borrowings at different rates; that all permanent improvements are assumed to have been made when the operation started; and that no extra expenses occur, as a thinning made at a loss or a disastrous fire. However, Formula 14 can be modified to take account of these and innumerable other such cost changes. For example, if a fire tower is built 10 years after stand establishment, an independent computation, using Formula 2 to determine its carrying charges, reducing its n by 10 years, is necessary. In working a problem involving such irregularities, it is well first to construct a formula to cover all irregularities before starting calculations even though it requires a dozen items. Furthermore, to get a proper cost picture, each item should be calculated separately even when it is mathematically possible to group them.

As an example of the working of Formula 14 in a not very complicated case, assume that a stand of southern pine will yield 80 cords of pulpwood in 50 years. Land cost is \$3.00 per acre. The permanent improvements necessary on the forest, prorated on an acreage basis, amount to \$0.25. Annual taxes (t) are \$0.08, and fire protection and administration (p) amount to \$0.10.[1] What will it cost per

[1] There is, of course, no assurance that taxes and protection costs will not change while the stand is growing. If such changes are expected, they can be

acre and per cord to bring the stand to maturity if interest is at 5 percent?

Inserting each item separately we get

$$GC = L(1.05^{50}) + I(1.05^{50}) + \frac{t(1.05^{50} - 1)}{0.05} + \frac{p(1.05^{50} - 1)}{0.05} - (L + I)$$

$$= 3.00(11.47) + 0.25(11.47) + \frac{0.08(11.47 - 1)}{0.05}$$

$$+ \frac{0.10(11.47 - 1) - (3.00 + .25)}{0.05}$$

= 34.41 (land) + 2.87 (improvements) + 16.75 (taxes) + 20.93 (protection, etc.) − 3.25 (land and improvements) = \$71.71 (cost per acre)

Since the yield is 80 cords, \$71.71/80 = \$0.90 (cost per cord).

B. Net Costs. As explained in Section 3, incidental receipts, derived from a stand during its growth, are treated from an accounting point of view as reducing final cost of production. Two accounting procedures are possible for doing this: (1) To handle them on a cash basis by reducing the cost of production in the year or years when they occur. Thus, if the total cost of production for the thirtieth year was \$2.00 per acre and returns from thinnings in that year were \$0.75 per acre, the cost of production that year would be reduced to \$1.25. (2) To treat them as if they were deposited at interest the year on which they are received and so continued until the end of the rotation. By this method the actual net receipts, plus interest, operate to reduce production costs each year after they are received. The theory behind this procedure is that incidental receipts, since they do not represent profit, remain with the enterprise and are presumed to be used productively (Chapt. VI, Secs. 2 and 9). If they are treated as profit and are distributed to owners, they cannot be regarded as reducing expenses; therefore, Procedure 2 is the correct one.

Incidental revenue may be annual, periodic, or irregular. An example of annual revenue is the lease of hunting and fishing rights on a private forest and the grazing receipts on a public forest. Periodic revenues are mostly from thinnings made at regular intervals. Irregular revenues usually are thinnings at varying intervals. All these receipts, plus interest, may be totaled to the end of the rotation by the

taken account of by substituting whichever one of Formulae 16 to 19 meets the needs of the problem (Chapt. XVII, Sec. 6).

use of Formulae 2 and 6 as they apply, making the necessary deductions for the length of n if the receipts do not occur annually. Thus, if the length of the rotation is 50 and a thinning is made in the thirtieth year, n is reduced to 20. The letter t is used generally to indicate the year at which a receipt appears, and the period that interest runs is indicated algebraically as $n - t$. These receipts then may be totaled to the end of the rotation and subtracted from the results obtained from the gross-cost formula (Formula 14) to give the net cost.

A net-cost formula also may be constructed by inserting the receipt items in the gross-cost one, preceded by a minus sign, incidental receipts being indicated by T and net cost by NC. By this method we obtain

$$NC = II(1.0p^n) + \frac{AR(1.0p^n - 1)}{0.0p} - T(1.0p)^{n-t} - (L + I)$$

[*Formula 15—Net Cost of Producing a Stand of Timber*]

Formula 15, like Formula 14, is here reduced to its simplest form and, like it, may be built up to cover as many items as required, using such symbols as are desired to express receipts other than thinning. If more than one thinning occurs, T_1, T_2, T_3 $\cdots$ are generally used to differentiate them.

As an example of the workings of Formula 15, use the same figures as in the example in Section 11*A*, but assume that a thinning was made in the twenty-fifth year which netted 5 cords of pulpwood sold at \$1.00 per cord and that this thinning also increased the final yield to 85 cords. Following are the calculations.

$$\begin{aligned} NC &= I(1.05^{50}) + L(1.05^{50} - 1) + \frac{t(1.05^{50} - 1)}{0.05} + \frac{p(1.05^{50} - 1)}{0.05} \\ &\quad -T(1.05)^{25} - (L + I) \\ &= 3.00(11.47) + 0.25(11.47) + 0.08\frac{(11.47 - 1)}{0.05} + 0.10\frac{(11.47 - 1)}{0.05} \\ &\quad -5.00(1.05)^{25} - (3.00 + 0.25) \\ &= 34.41 + 2.87 + 16.75 + 20.93 - (16.93 + 3.00 + 0.25) \\ &= 74.96 - 20.18 = \$54.78 \text{ (cost per acre)} \end{aligned}$$

The cost per cord of the final crop would then be \$54.78/85 = \$0.644

11. CAPITALIZATION AND ENDOWMENT OF COSTS

It is evident that the estimated costs of production of a stand can be discounted to the present, and that the sum thus obtained, if put

at interest at the same rate as used in discounting, would meet the costs as they came along. Thus in the problem introduced in the last section, if the owner had desired to know what sum he could put at interest when he bought his land to discharge his annual taxes as they came due, he could determine the sum by using Formula 7, the Present Value of an Annuity: $V_0 = AR(1.0p^n - 1)/0.0p \times 1.0p^n$. It would also be possible for him to do the same for all the expenses, either independently or as a lump sum.

Procedures of this kind are frequent in financial transactions when funds are being set up to cover anticipated expenses. A common example are endowment funds, established by donors of university buildings to care for their maintenance. The procedure is also useful in business for purposes of long-term budgeting and can be used in forest investments.

12. PRODUCTION COST AND LENGTH OF ROTATION

In Section 10 the cost of producing a crop of timber on a definite rotation [1] age was figured. It is obvious that if a shorter rotation had been chosen, the cost would have been less, but less pulpwood would have been produced. If a longer one had been picked, more pulpwood would have resulted, but the cost of producing it would have been greater. This raises the questions: At what length of rotation will the cost of production per unit be the cheapest? And at what age will the maximum profit be made in growing pulpwood?

In exploring these very fundamental questions it is well to remember that the volume of an even-aged stand increases rapidly in its early years but more slowly as it approaches maturity, after which it declines from decay and death. The expected growth curve of a stand can be plotted from yield-table figures as was done in Fig. 44. By applying unit-value figures to the yield at different ages (in other words, constructing a financial yield table) (Fig. 46), a curve of increase in value to maturity may be constructed. It is also possible to plot a curve on the same sheet, showing the costs of production at different ages. Figure 46 shows such a combination, in which Curve 1 shows the increase in stumpage value on an acre of Douglas fir stumpage on Site III in the Pacific Northwest at ages up to 160 years. The basic stumpage value, taken at $1.50 per M. ft. b.m. for a 30-year stand, is increased by $0.15 per M. ft. for each succeeding decade solely

[1] The general term "rotation" is defined in forestry as "the predetermined period of years required to establish and grow forest crops to a specified condition of maturity."

on the basis of increase in grade of material. No general price increase over the base price, due to expected better general price conditions, is included. Curve 2 shows the cost of production on the basis of the following assumed costs: land and improvements, $1.00 per acre; cost of establishment of stand, $3.00 per acre; taxes, protection, and administration, $0.10 per acre per annum. All funds used are assumed to have been borrowed at 3 percent. Curve 3 shows them at 5 percent.

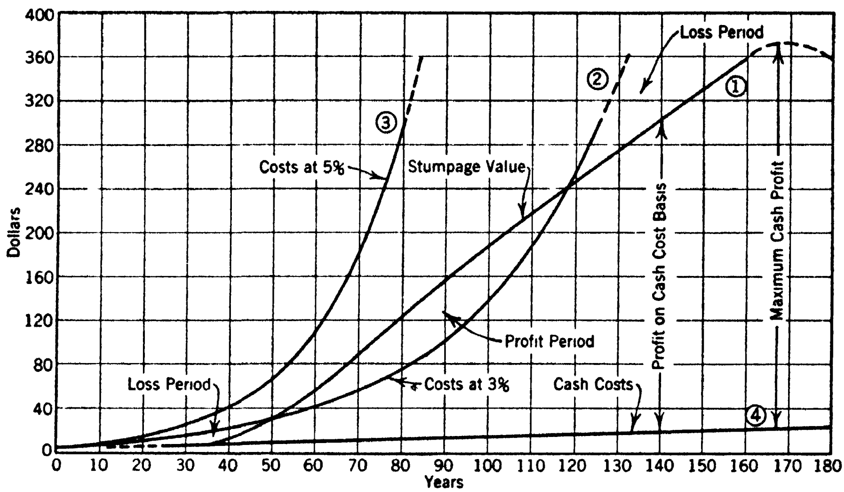

FIG. 46. Stumpage value of an even-aged stand of Douglas fir at different ages, compared with its cash and other costs of production. The figure shows years during which a profit may be obtained. [From H. H. Chapman, p. 298, *Forest Management,* after Technical Bulletin 201, United States Department of Agriculture.]

Curve 4 shows the cash costs of production without any interest. It is immediately evident from a comparison of Curves 1, 2, and 3 that at 5 percent the increase is so much more rapid in costs than that in value that an enterprise cannot be profitable on that basis but may be at 3 percent.

A further comparison of Curves 1 and 2 brings out the following significant points: (1) Up to the forty-ninth year the cost of production is greater than the value of the stumpage. (2) After the one-hundred-and-twelfth year the cost of production again exceeds the value of the product. (3) Between the forty-eighth year and the one-hundred-and-twelfth year, value of product is greater than production cost. In other words, during about only 70 years out of the 160 years it takes the stand to reach maximum volume is a cash profit possible. (4) At about the ninetieth year the cost curve is the lowest

in relation to the value curve, which would indicate that on the basis of these somewhat arbitrary figures the best length of rotation would be 90 years (see also Sec. 13).

There are, of course, other factors which influence the fixing of the length of a rotation, chiefly a desire for products of special sizes or grades or a desire to take advantage of the period of most rapid volume increase, but the curves in Fig. 46 bring out the chief economic factors involved,[1] which in one way or another must be considered in all calculations of profits in forestry; this is the subject of the next section.

13. CALCULATIONS OF PROFITS IN FORESTRY

The calculation of profits in forestry as a going business with crops maturing every year (Chapt. XV) does not differ essentially from that in other businesses. What concerns us here is the estimation of profit (or its determination after harvest) on the production of a single crop of timber. There are several complicated methods of so doing, revolving mostly around refinements of methods of determination of the length of rotation that yields the maximum soil rent[2] (Chapt. XIII, Sec. 7). Only the two simplest methods are considered here; namely, that of determining the discounted value of estimated net cash profit of the crop and that figured in terms of the rate of interest earned on the capital invested.

In demonstrating them we shall use the same figures as employed in developing the graphs in Fig. 46, where we saw that a cash profit would be obtained over a long span of years but was at its maximum in the ninetieth year. By the use of Formula 5, Compound Discount, $V_0 = V_n/1.0p^n$, we can determine the present value of the crops for different years, and by using Formula 10, Rate of Profit on an Investment Maturing in the Future, $1.0p^n = V_n/V_0$, we can calculate the profit on the capital invested. The following tabulation gives the figures at 10-year intervals.[3]

It is evident from this tabulation that the period of highest cash profit, namely from the eighty-fifth to the ninety-fifth period (assumed in Section 12 to be at its maximum in the ninetieth year), is not, whether measured by present value or return on invested capi-

[1] H. H. Chapman, *Forest Management*, Chapt. XXI, John Wiley and Sons, New York, 1931, gives an excellent description of all these methods.

[2] Chapman, *op. cit.*

[3] The initial cost of the land, which is a permanent asset, has been subtracted (Sec. 10).

Years	*Cash Profit* [1]	*Present Value of Crop*	*Interest on Investment*
55	$ 9.00	$1.77	2.0
65	24.00	3.51	3.3
75	40.00	4.36	3.5
85	52.00	4.21	3.4
95	52.00	3.21	3.0
105	40.00	1.79	2.5
115	12.00	0.40	1.2

tal, the year of maximum return. This appears to be the seventy-fifth year, but more refined calculations might show it to be slightly earlier.[2] An operator therefore probably would conclude that 70 years was the most profitable rotation, on the basis of capital invested, but he might not be enthusiastic as to the interest rate earned unless he remembered that this was compound interest (Chapt. VI, Sec. 8*J*).

The assumption was made in Section 12 that the base price did not increase. If he had chosen to assume an increase, due probably to greater demand for his product, his value curve would have stood at a higher level, crossed the cost curve at both an earlier and a later date, and the two curves would have been farther apart at the year of maximum profit however figured. If, without any changes in cost of production, stumpage turned out to be worth twice as much on the sixtieth year as the estimate here used, the owner could cut his stand and make 5 percent on it then and there.

Since the higher stumpage prices rise, the smaller the size of the marginal tree (Chapt. X, Sec. 2), the more rapidly the value curve will rise, and therefore the shorter the rotation which will yield the maximum return on invested capital. Consequently, intensive forestry is likely to make use of very short rotations, and extensive forestry of very long ones (Sec. 2). Under extremely favorable market conditions, rotations may be made so short as to introduce silvicultural complications in securing reproduction[3] and to have social disadvantages in that products of large size and high grade are not produced because it is more profitable to grow those of small size and low grade.

[1] Figures are rounded to nearest dollar.

[2] This corresponds to the so-called "financial rotation," defined as "the period of years required to produce the highest rate of compound interest return on all capital invested in production."

[3] Chapman, *op. cit.*

This sort of combined study of length of rotation and profit possibilities may be used to compare the advantages of (1) growing different species, (2) growing different products, and (3) using different methods of treatment. As examples: (1) Which will yield the greatest profit on a 100-year rotation—white or red pine? (2) To point conclusions on the relative financial advantages of growing pulpwood —which is possible on fairly short rotations; with lumber which requires longer ones? (3) To investigate the question of advisability of early thinning as compared with later ones or of no thinnings at all (Sec. 7)?

As a final point in the profit-and-rotation discussion, let us return to Fig. 46 and examine the relation between Curves 1 and 4. Curve 4 shows only the sums of the annual cash costs of the operation. It is evident that, since they represent a straight-line progression, they will not exceed the value of the crop until after it has fallen into decay and that the two curves are the farthest apart when the stand reaches its maximum volume, when its sale value is supposedly the greatest. At the prices quoted, it would bring about eight times what it would have brought 90 years earlier under the financial rotation. If we neglect interest and consider only the maximum physical production and maximum cash return, the rotation used is known as that of forest rent (Chapt. XIII, Sec. 7).

It is not surprising that generations of foresters have examined figures such as these and wished that compound interest could be abolished in forestry. Of course an owner who is wealthy enough can neglect it so far as his personal calculations are concerned, and forest properties can be built on an entirely different investment theory without regard to it (Chapt. XIX, Sec. 4*B*). It will also be shown later (Chapt. XV, Sec 4) that under sustained-yield forestry, where the proceeds of each annual crop pays the indebtedness of the previous ones, compound interest disappears as a practical matter. It can also be disregarded on public forests—if the public does not insist on a financial accounting. But, as a practical matter, could any corporation be expected to hold its product off the market when the costs of so doing are greater than the possible return even though sale value is increasing?

Even under sustained-yield forestry where interest can be neglected and the forest-rent theory applies to the extent that land and timber are valued jointly, the rotation which will yield the maximum of return on the investment in land will be much shorter than the forest-rent rotation above described. In public forestry, unless its objective is to secure a financial profit (Chapt. XX, Sec. 5), it is possible, of

course, to use much longer rotations than are economical in private forestry. It may be sound public economics in order to supply a demand for large-sized and high-grade material which would not be produced otherwise. Even then it may be carried to extremes and result in the piling up of large timber reserves, contributing little to current economic needs (Chapt. XX, Sec. 4*B*).

14. FOREST BUDGETS

The literature of forest management is full of discussions of cutting budgets, under which a forest is supposed to operate, so that the annual or period cut may be increased, decreased, or kept stationary, according to technical and economic necessities. A financial budget is equally necessary on a forest under orderly management so that funds are provided for the necessary capital and current expenditures required for crop production and protection.

This budget, like other aspects of a management plan, must be in both long and short terms. Its long-term provisions must provide for the investment in permanent improvements, which must be constructed at different periods (Sec. 4), and in silvicultural improvements, which are in the nature of investments, such as thinnings that yield no immediate return. In its short-term features it must provide for current expenses. Such a budget must include depreciation charges on equipment and physical improvement and on amortization and sinking-fund provisions—provisions similar to those described in Sections 4 and 6 in Chapter VII for a lumber operation. If the forest capital is being built up, no depletion charge (Chapt. VII, Sec. 5) is required. If there is a surplus of old-growth timber which is being reduced (Chapt. XV, Secs. 6*A* and *B*), it should be included until this is liquidated.

CHAPTER XV

SUSTAINED-YIELD FORESTRY

Forestry may be practiced on a basis of *discontinuous* or *continuous* harvests. When *all* the mature timber is removed from a forest at one time (excepting that left to establish reproduction), a new crop will not be ripe for many years, perhaps nearly a century. This is an extreme instance of discontinuous-harvest forestry—one cut per long rotation. If this forest contained enough immature timber to provide a second cut in fifty years, it could then provide two harvests per rotation. If it is managed so as to harvest an annual crop, it would be on continuous production, or as it is called, *sustained-yield* forestry.

Discontinuous harvest, or non-sustained-yield forestry, may be sound silviculturally but usually has economic drawbacks. As a business enterprise forestry is possible only if it provides annual returns. The owner of a small forest, not dependent on it for his annual income, may find it advantageous to manage his woods on a discontinuous-harvest basis, and a large owner who does not care to consider sustained yield should profit by leaving his property in shape to reproduce itself after cutting all the merchantable timber in a single operation. Discontinuous-yield forestry if conducted on the basis of occasional cuttings is usually a subsidiary enterprise. If it involves waiting a full rotation for a second cut, it is a long-term, delayed-return investment. On a sustained-yield basis forestry is a going business.

1. THE MEANING OF SUSTAINED YIELD

The term sustained yield is often loosely used. According to some, its requirements are satisfied when a forest is cut so that reproduction is provided for; in other words, harvests do not need to be continuous. From the previous section it is apparent that this concept robs the term of all meaning when applied to a single forest. However, under some conditions it may have a meaning for a group of forests that supply a single market (Sec. 2).

A sustained-yield forest sometimes is considered equivalent to a normal forest, which is defined by the Society of American Foresters [1]

[1] Unpublished report. Committee on Forest Terminology.

as: "A standard with which to compare an actual forest to bring out its deficiencies for sustained-yield management. An ideally regulated or organized forest with normal increment, normal age classes in area and distribution, and normal growing stock." Sustained yield is defined by the Society of American Foresters[1] as "The concept of so managing a forest property that a volume of timber or other products sufficient for annual or periodic harvests will be available indefinitely." This corresponds to the concept outlined in Section 1 but avoids commitment as to whether the annual or periodic harvests must be of equal volume and how much longer than one year the period may be. Obviously, the cuts cannot vary widely from year to year, nor can the period be stretched much beyond a year or two and meet the requirements of a going business. When sustained yield begins, frequently it is necessary to cut less or more than the annual growth, depending on the condition of the forest (Sec. 6). Eventually the annual cut must approximate the annual growth. When this point is reached, the forest may be said to be on a *full sustained-yield* basis even though it does not satisfy all the requirements of a normal forest.

In dealing with sustained yield it is well to remember that it does not necessarily require that each portion of the forest be itself on sustained yield or that clear cutting not be employed as a silvicultural system. A sustained-yield forest may consist of uneven-aged stands, two-storied stands, a collection of even-aged stands of different ages, or a combination of all. This is determined by silvicultural and management factors. The essential is that approximately an equal volume of timber matures each year so that cutting may be carried on in an orderly fashion, modified only as necessitated by economic factors.

2. REGIONAL SUSTAINED YIELD

Sustained-yield forestry has both producer and consumer aspects. The landowner is the producer, within limits discussed in Section 1; he must if his operations are to be continuous operate on sustained yield.

From the consumer viewpoint, whether that of the ultimate consumer or of the conversion plants dependent on stumpage or log purchases (Chapt. XIX, Sec. 5*C*), an even flow of raw material is likewise necessary but *does not need to come from a given forest under one ownership.* The need is simply that it be available within economic hauling distance. The unit of yield, called in forest management the *working circle,* may therefore be a single forest under one

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[1] Unpublished report. Committee on Forest Terminology.

ownership or a group of forests under separate ownership, all, part, or none of which may themselves be on a sustained yield. Thus, if there were 50 owners, each with the same acreage in a working circle where the rotation was 50 years, each forest might be clear cut every fiftieth year and the consumers would be satisfied.

This is sometimes stretched to the point of treating the whole United States as a single working circle and trying to determine whether its forests are growing as fast as they are cut—the assumption being that, if they are, national sustained yield has been obtained and everyone should be happy. This neglects freight bills and regional prosperity (Chapt. X, Sec. 3, and Chapt. IX). Sustained yield must be on a regional basis. The region must be an economic unit in which production and consumption balance to the extent that there is a continuous and even flow of raw material to supply local plants and to keep local labor employed. Whether the final products are used locally or whether they are shipped to outside consuming regions is not important, provided there is a market they can reach. In regions of large individual ownership, a single forest may constitute a self-contained sustained-yield unit; elsewhere different owners must cooperate, the larger ones being on sustained yield, the smaller ones not necessarily so. The size of such regions varies, but the problems of sustained yield generally are simpler on large areas than on small ones.[1] Chapter XXI discusses public assistance to obtain cooperative sustained yield in regions of diversified ownership. The rest of this chapter is concerned with sustained yield from the viewpoint of the individual forest owner, chiefly the large industrial or the non-manufacturing forest owner who is in the business of selling stumpage (Chapt. XIX, Sec. 4*D*).

3. SUSTAINED-YIELD FORESTRY AS A BUSINESS

The outstanding characteristic of sustained-yield forestry as a business is that it provides a continuous and reasonably fixed annual supply of raw material from a definite area of land as long as the owner makes the necessary expenditure to establish a new crop each time one is harvested.[2] By following this procedure, those selling or converting their own stumpage to finished products may solve the perpetual problem of "more stumpage." Nevertheless, sustained yield does not solve all other business problems. It provides a perpetual

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[1] A sustained-yield region is obviously one living on a permanent forest economy (Chapt. IX, Sec. 5).

[2] n being the years in rotation, for $n - 1$ years thereafter should he cease doing so (Chapt. XIV, Sec. 12).

supply of raw material in a way comparable to a contract to deliver at an unspecified price. Each crop costs a different sum, depending upon changes in taxes, wage rates, and other expenses, and sells at amounts which vary with price levels. Therefore, it is not a guarantee of any rate of profit. However, it permits enough leeway to increase or decrease somewhat the annual cut to meet the requirements of the business cycle,[1] but too great cutting in boom times impairs the future capital by cutting in younger age classes. Moreover, too much lag in depressions throws the future crop series out of adjustment.

The capital value of the enterprise will vary with its earning power, as in any other business (Chapt. VII) even though its capital in growing stock remains approximately fixed (Fig. 10), but the value of each individual age class is increasing (Fig. 9). Since the timber removed annually is of approximately the same volume, and the same area is worked over every so many years, no further investment may be necessary once the logging and other improvements have been installed; only the upkeep and replacement need be provided for.

4. INTEREST CHARGES AND SUSTAINED YIELD

Much emphasis has been laid on the heavy interest charges accumulated in the process of building up a producing forest (Chapts. X and XIV). Once a forest has been placed on a sustained-yield basis, these charges in effect disappear, as is illustrated by a simple case although it is not likely to be encountered in practice (Sec. 6*E*). Assume an operation in growing pulpwood on a 30-year rotation. An equal area is planted annually. On the thirtieth year the first plantation is harvested and the debt which it has accumulated is discharged. On the thirty-first year the second plantation is harvested, its debts discharged, and so on. The funds for re-establishment of stands from the thirtieth year on are available from the annual cuts. At the end of the sixtieth year all the original debt has been discharged and the operation proceeds on annual returns covering annual costs. Each year a new expenditure is required to secure reproduction which will not be merchantable for 30 years, but it is made from the profits of an older expenditure; therefore, in reality it is an annual maintenance charge to keep the operating plant functioning, to be

[1] Often this cannot be done on liquidation operations where a fixed sum must be paid on borrowed capital. Therefore, it may be necessary to overcut in low-priced periods to raise the necessary money.

regarded in the same light as one to keep a logging road in good condition.[1]

While, of course, it is true that each expenditure for reproduction may be treated on an investment basis and interest charged against it, unless the money to do so is borrowed the only reason for so doing would appear to be for accounting and cost determination.[2] So far as the growing stock is concerned, a deferred-payment investment has run its course and been put on an annual payment basis with a 30-year capital turnover.

This does not mean necessarily that the enterprise will have no interest to pay. That will depend upon the extent to which it operates on borrowed capital, requires special borrowings for new improvements, needs extra working capital to tide it over emergency periods, runs into debt, and so on. Because the enterprise operates on the basis of annual returns, it is in a position to meet interest charges of this nature from current income and can borrow, therefore, at simple rather than compound interest.

5. SUSTAINED-YIELD FORESTRY VERSUS FOREST LIQUIDATION

Once a forest has been put on the basis of a regular and perpetual output, the advantages of sustained yield are generally admitted, but it does not follow that it is more to the financial advantage *of an owner* to place it there than to liquidate it. The establishment of forestry as a private business in general and in particular depends largely on the answer to this question.

Let it be remembered that (1) under liquidation a sum is invested in timber and conversion facilities. The timber is cut, manufactured, and sold. The difference between the total invested and the amount received from sales is profit. If land was purchased to get stumpage, it is sold for salvage or abandoned along with improvements and equipment that cannot be moved. Those wishing to remain in business then must invest in more timber and new facilities out of the proceeds of previous operations. Remember that (2) forestry is a

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[1] Since the costs of each crop will differ, this canceling out is not, of course, an exact process any more than it is in everyday business transactions, but depends on averages.

[2] If the costs of stand establishment can be passed on to the consumer of the products harvested when the operation is completed, even a bookkeeping charge would seem unnecessary. Assume that the consumer is charged $0.10 extra per thousand feet board measure for seed trees left to establish reproduction after clear cutting. The lumberman is getting them paid for at once, not when the new crop matures.

permanent rather than a self-liquidating investment. Capital, once invested in the land, remains there continuously, yielding dividends from successive crops. It is comparable to agriculture except that the money is tied up in each successive crop for many years instead of a few months. Since the financial advantages of liquidation as compared with sustained yield on a given forest are often extremely difficult to determine, it is well to set down briefly their general advantages and disadvantages.[1] Liquidation ordinarily permits capital recovery within a predetermined period which may be made short enough to permit reasonable estimate of future earnings. If, when the operation is concluded, prospects remain good, the capital may be reinvested in further stumpage; if not, it can be put to other uses that appear to offer better returns (Chapt. XIX, Sec. 5). Its salient disadvantages are: (1) It permits only a very low rate of profit on trees slightly above the marginal limits (Chapt. X, Sec. 2), and none at all on those under it. (2) The investment in plant must be written off in a definite term of years, frequently long before it is physically worn out or obsolete, and the cutover land is usually of little or no value; consequently, the depreciation and depletion rates must be high (Chapt. VII, Sec. 4). To meet them, operations must be carried on at as near maximum capacity as possible (Chapt. VIII, Sec. 2*C*). (3) When liquidation is completed there is an inevitable loss, due to changes in labor, working conditions, and marketing methods, due to moving to a new and often distant location. (4) Liquidation operations cannot be continued forever, unless man or nature grows forests fast enough to keep ahead of it. It becomes progressively unprofitable[2] in the face of rising stumpage prices not compensated by increasing selling prices of the final product.

The advantages of sustained yield are: (1) It permits later harvesting of immature timber at the most profitable time. (2) Since it provides for a continuous supply of stumpage on the same area, the necessity for high depletion and depreciation charges (Chapt. VII, Sec. 4) and low salvage values is obviated. Durable improvements having long physical life and low operating costs may replace temporary ones having high operation and maintenance costs. It also

[1] It should be remembered that the various points raised here apply only to the forest owner, not to the public, to which the advantages of sustained yield are incontestable.

[2] Despite what has been said in Chapter X, Section 4, stumpage prices can rise in expectation of final product price rises, which may not occur (Chapt. XI, Sec. 4). Government price fixing of final products may induce the same result (Chapt. XXI).

obviates the losses incident to moving or the possible necessity of paying through the nose for new stumpage. Its disadvantages are that it fixes capital in an enterprise from which profits in the distant future are unpredictable. If they do not materialize, the salvage value of immature timber and the equipment to manufacture it, which is part of the investment, is bound to be low.

One further point of contrast between liquidation and sustained-yield operations is of great importance in appraising their relative advantages; that is, the amount of timber that can be obtained from the same area under the two systems. It needs no mathematical demonstration to prove that, if an acre is kept at work producing continuous crops, it will produce infinitely more than it can at any one time. Nevertheless, when a forest reaches a sustained-yield basis, most of its area must be in immature growing stock; consequently the annual cut must be less than can be obtained annually from a liquidation operation *while it lasts*.[1]

The greater the proportion of mature timber in a stand and the larger the trees, the greater becomes this discrepancy. An acre of even-aged virgin Douglas fir, which nature has taken three or four centuries to grow, probably contains a greater volume than it could produce in two or three rotations of a length suited to human economics (Chapt. XIV, Secs. 12 and 13). Even an all-aged virgin hemlock and hardwood stand contains some veterans of several centuries whose individual volume is larger than it would be profitable to grow under forest management. In second-growth stands, whether even-aged, mixed-aged, or all-aged stands, the discrepancy is much less but never can entirely disappear. Therefore, from a financial point of view, liquidation has the advantage of producing a larger volume of timber for a fixed period from a given area. Sustained yield can produce a smaller volume in perpetuity from the same area.

From an investment point of view, a comparison between the advantages of the two systems as applied to a particular situation is between a relatively short-term investment with a higher annual return and an investment assumed to be perpetual with a lower annual return. The standard financial method of comparing such investments is to discount their annual profits to the present, using the same rate of interest for both (Chapt. VI, Sec. 7*C*). That investment having the higher discounted value is assumed to be the more profitable. As regards sustained yield versus liquidation, before this

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[1] This has nothing to do with the fact that the cut may be increased under sustained yield by increasing the area of the forest (Sec. 6*A*).

final step is taken, many problems must be studied and cost estimates made, for the operating costs under the two systems differ. We consider the problems in the next section.

6. PROBLEMS IN PLACING FORESTS ON SUSTAINED YIELD

Placing a forest on a sustained-yield basis involves difficult technical and economic problems. The technical ones pertain to silviculture and forest management. The economic ones are of a business and financial nature. Our primary interest is with the economic problems, but they cannot be considered independently. To facilitate the economic discussion, the technical problems have been somewhat oversimplified.[1]

The more a forest approaches a sustained-yield form, that is to say, the more it has an even distribution of age classes up to the rotation age, the simpler become both problems. The better the market conditions and the stronger the financial position of the owners, the easier the solution of the economic problems. It is usually easier to start operations on a sustained-yield basis on a forest that is not being exploited than on one that is (Sec. 6*D*).

We have to deal with the following general forms of forests: mature, even-aged forests, all-aged forests, immature forests containing some merchantable timber, forests of all classes that are being operated, forests established on bare land. They are discussed under the following subheadings.

A. Mature, Even-Aged Forests. In such a forest, practically all the trees are immediately merchantable, and clear cutting is silviculturally and financially advisable. To put such a forest on full sustained yield, the forester must determine the growth rate after cutting and the length of rotation necessary to produce a new crop, and then remove the original stand at such a rate that the first stands of the new forest will be ready for harvesting when the last of the old one has been removed.

In determining the rotation, he finds himself between two horns of a dilemma. The longer he makes the rotation, the slower the rate of cutting of the original stand, and hence the greater the carrying charges, and the longer capital is tied up in a stumpage which, having reached maturity, is declining in volume and possibly in value (Chapt. XIV, Sec. 13). The shorter he makes it, the less new timber will be

[1] Students should keep this in mind. Experts in silviculture and forest management are asked to forgive it in view of the major objectives of the discussion.

available for operations when the old is gone. But this dilemma, like a dragon, has many horns. If he removes the old timber in less time than the length of the rotation, there will be a period before the new stand is ready when there will be nothing to cut. Presumably, he will set his rotation with due regard for the highest profit possible from the second stand or for the size of product he wishes to grow (Chapt. XIV, Sec. 13). Even the shortest of such rotations is not likely to be less than 30 years. This usually involves carrying virgin stumpage a longer time than may be economically desirable.

The ideal solution is one that permits as rapid liquidation of the mature timber as is consistent with later securing an adequate cut from regrowth and at the same time does not involve too heavy carrying charges. To attain this solution it may be desirable to make further expenditures to buy more timber land in younger age classes which will be mature when needed, or more which is mature to be used as required Assuming that either or both are possible, the investment in land has been increased for the sake of future supplies (p. 305). Other possible solutions are to purchase logs or stumpage if available on the open market, or *to exploit the mature timber in terms of unit values instead of on a straight-volume basis.* As the latter method applies more or less to all types of forest and is probably the best one, it is discussed separately in Section 7.

Whatever solution is adopted, the second cut will consist of smaller-sized timber, which can be more economically handled by different-type logging and milling machinery than by that required for the big timber of the first cut. Consequently it is usually necessary to amortize the original equipment before the original timber is gone.

B. All-Aged Forests. Such forests have a considerable portion of immature timber and are, therefore, both less valuable for liquidation [1] and easier to put on a sustained-yield basis than mature, even-aged ones. When they are logged, it is economically necessary to leave the submarginal trees that, if protected, will form the basis of a second cut; but if the marginal limit is low, say, 6 in. d.b.h., it will be many years before they will yield much. Consequently the first cut must be spread over a long period or else a waiting period between cuts will be necessary. The same economic disadvantages result as on a mature, even-aged forest (Sec. 6*A*), although generally they will not be so serious. The difficulty can be overcome by leaving trees above

[1] That is judged as a logging proposition. Variations in stumpage value, due to differences in species and relation to markets, would affect the value per thousand feet board measure of the merchantable timber.

marginal limits, but this decreases the amount of material obtained in the first cutting period in order to provide a larger one in the second. The more trees left above the marginal limit, the longer it will take to retire the original investment in stumpage and, unless the cutting period is shortened, the less the annual cut.

The technical problem of putting an all-aged forest on a sustained-yield basis, barring difficulties in determining the growth rate after cutting,[1] is simply one of determining the rotation to be used and of adjusting the annual cut on the basis of diameter and age limits so as to space it over a period long enough to insure approximately equal cuts in perpetuity. The difficulty comes in making the business adjustments mentioned in Section 6*A*. They are, however, less serious. Further discussion is deferred to Section 7.

C. Immature Forests. Such forests may be of all sorts of forms or combinations of forms, of even-aged or mixed-aged stands, predominately young, or approaching maturity. They often contain much material in the form of submarginal species and worthless old growth left from previous cuttings. Economically, their dominant character is their comparatively low value, due to their small volume of merchantable timber. The technical problems of putting immature forests on a sustained-yield basis vary almost as widely as do the forests themselves. The essential is to keep the early cuts low in order to build up a growing stock and to remove as much worthless material as possible in the course of operations. If this is done consistently, the size of the annual cuts may be progressively increased up to the limits of technical and economic possibilities.

Those exploiting such forests (assuming that they contain enough immediately commercial material to justify any cutting) are under pressure to secure the largest possible volume and are unwilling to go to the extra expense of removing what is of no prospective value, even knowing that the removal will increase future yields (Chapt. XIV, Sec. 7). Success in solving the problem will depend upon the financial strength of the owners, their willingness to wait for returns, and the course of the market conditions in the region in which they operate. The better the market for low-grade material that it is desirable to remove for cultural reasons, the easier the problem.

D. Forests Already Being Exploited. The above cases considered the problems involved in putting a forest on sustained yield before its exploitation by either method began. Suppose liquidation opera-

[1] See any text on forest mensuration.

tions are in progress; the owners may wish to investigate the advantage of a change to sustained yield. This involves complications which are not encountered in forests not being exploited. They come from the fact that mills, logging equipment, transportation and operating methods, sales policies, labor, and technical force, have been built up to a certain output. If the operation is shifted from liquidation to sustained yield, either this scale must be reduced, which involves scrapping and losses in material and human investments, or the investment must be increased by purchasing the added land and stumpage necessary to continue operations on the same scale. (The land already cutover under liquidation operations usually will be of little value and, under some conditions, a complete loss for sustained-yield purposes.)

E. Planted Forests. This is the simplest case technically, but the most difficult economically. From a management point of view, all that is necessary is to decide on the length of rotation and divide it into the number of acres in the proposed forest. The resultant figure is the size of the area to be planted annually to get a sustained yield, beginning when the first plantation matures (Sec. 4).

This method involves a continually rising investment upon which no return is possible until the first planting is ready to harvest and the investment for the last planting does not mature until the end of the second rotation (Sec. 4). Despite its technical advantages, the procedure has no business possibilities because the business of growing plus harvesting cannot begin for many years after the first investment is made.[1] It is unfortunate that forest industries often have conceived forestry in terms of such a series of plantings and have rejected without consideration its other aspects. Considered solely as an investment by persons not themselves dependent upon an immediate return, or as a current supply of timber for sale or manufacture, building up a forest by systematic planting may assume a more favorable light, depending upon a combination of financial and psychological factors (Chapt. XIX, Sec. 4*B*). Its use in public forestry for reforesting large denuded areas in an orderly fashion is, of course, sound economically.

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[1] This does not mean that forest planting, used as a method of reproduction on a forest that is being operated or as a means of filling blanks on such a forest, is impractical or necessarily uneconomic. Returns are coming in to meet the costs as they occur from a business already established. This is done more or less on private forests, particularly those producing pulpwood. The cost factors involved were discussed in Chapter XIV.

7. COMPARING PROFITS FROM LIQUIDATION AND SUSTAINED YIELD

A study of the relative financial advantages of liquidation and sustained yield embraces two main steps: (1) an appraisal of the value of the stumpage on the area if liquidated within a short period, compared with its value if liquidated over a full rotation or an infinite series of rotations; (2) the reduction to terms of present value of the values obtained over these two periods.

The appraisal methods are treated in some detail in Chapter XVIII, Sections 6 and 7, but their principles can be grasped by keeping in mind (1) that the value of a tree, or of a stand which is uniform in character, varies with its contents, grade, and location (Chapt. X, Sec. 2); (2) that the profit from exploitation of trees or stands increases rapidly with their size and grade (Figs. 24 and 25); (3) that the cost of logging decreases with the amount of timber obtained from an area until trees of such small size are included that the added cost of handling increases the total cost (Chapt. X, Sec. 3); (4) that the longer the liquidation period, the more submarginal timber will become supermarginal and the more timber that is slightly above marginal limits will increase in value; (5) that if the liquidation period is extended to the length of a rotation, even the seedlings on the area will have become merchantable.[1]

Comparison of the advantages of the two systems of cutting calls for (1) an appraisal of the timber as it stands, valuing only in terms of a short liquidation period and therefore considering nothing which is not above marginal limits when the operation starts; (2) an appraisal in terms of a series of cutting cycles [2] which values the timber, mature and immature, in terms of the date when it will be harvested.

In all-aged forests this second appraisal is made in terms of age and diameter classes, with necessary recognition of different values for different species and grades. It is often called the *diameter analysis method.* In even-aged stands where there is little variation in diameters and nearly all trees are merchantable so far as dimensions are concerned, it must be made largely in terms of grades, species, or loca-

[1] Points 4 and 5 assume that the logging methods used do not destroy what is not harvested and take no account of possible losses from death and decay of overmature timber (Chapt. XVIII, Sec. 5).

[2] For our purposes, the cutting cycle is defined as "the planned period within which all portions of a working circle are logged in orderly sequence, removing from each portion the timber scheduled for cutting at the time." From Society of American Foresters, unpublished report of Committee on Forest Terminology.

tion, and volume of stands, those having the lowest volume and poorest grade and which are the most expensive to exploit being given the lowest value. This is called the *stand analysis method.*

On the basis of such an appraisal, two or more cutting cycles are laid out with due regard to the technical and financial problems described in Sections 5 and 6. The intent is to provide for the removal of the most immediately valuable timber in the earliest cycles and to leave that which is increasing the most rapidly in value from growth or which may be expected to do so from economic causes for the later cycles. Since the two operations will be different in technical and financial nature, it is necessary to build up an entire cost picture of each, showing their expected annual profit (Chapt. XVIII, Secs. 4, 5, and 6). It may be expected that the liquidation operation will show a higher profit *while it lasts,* and the sustained yield a lower one over a longer period (Sec. 5). Which has the higher present value? Assume an annual profit of \$150,000 per year for a 5-year liquidation period and a \$35,000 profit over a 50-year rotation. Interest is at 5 percent. Comparison consists in discounting two annuities. Formula 7 is $V_0 = AR(1.0p^n - 1)/0.0p \times 1.0p^n$. The calculations are

$$\text{(1) Liquidation value,} \quad V_0 = \frac{\$150{,}000(1.05^5 - 1)}{0.05 \times 1.05^5}$$

$$= \$150{,}000(4.3295) = \$649{,}425$$

$$\text{(2) Sustained-yield value,} \quad V_0 = \frac{\$35{,}000(1.05^{50} - 1)}{0.05 \times 1.05^{50}}$$

$$= \$35{,}000(18.2559) = \$638{,}965$$

It is evident that in this instance there would appear to be little difference between the financial advantages of the two systems. But, if it is assumed that once the forest was on sustained yield the returns would be perpetual and not merely for one rotation, Formula 8, Capital Value of an Annual Rental, $V_0 = AR/0.0p$, then comes into play. Using it, we get $V_0 = \$35{,}000/0.05 = \$70{,}000$, and it would appear to be advantageous to operate the forest on sustained yield. As a practical matter, an owner probably would require a considerable margin of higher present value in the first rotation to convince him of the advantages of sustained yield but, being so convinced, would be willing to take later rotations for granted (Chapt. XIII, Sec. 6*A*). Probably he would also want to compare the interest return on the capital invested in each type of operation, as was done in the length of rotation example in Chapter XIV, Section 13.

It should be understood that the application of these simple formulae are the end results of a long series of involved financial calculations to determine the figures used. Different appraisors, using different methods or even the same methods, will secure different figures showing different results. Different accountants, working on them, will weigh them differently, for higher accounting is not an exact science like bookkeeping but operates on various theories as to the relative importance of the elements of profit.[1] A universally approved system of higher accounting in forestry is necessary apparently before it is possible to present the profession with the necessary tools for a complete and authoritative analysis of this most important problem of sustained yield versus liquidation. Meanwhile a thorough knowledge of the elements of stumpage value for exploitation under different logging methods is an invaluable tool of every forester and must serve as the basis of financial analysis. It is considered further in Chapter XVIII.

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[1] See the long series of articles criticizing and commenting on an anonymous article published in the *Journal of Forestry,* November, 1938, entitled *"Sustained Yield versus Clear Cutting."*

CHAPTER XVI

THE ECONOMICS OF PROTECTION, RECREATION, AND WILDLIFE FORESTRY

The nature and usefulness of protection, recreation, and wildlife forests were discussed in Chapter IX. They differ from timber-production forests in that, instead of yielding a profit when cut and sold, they can produce a profit of the kind desired only while they are standing. Cuttings, if made, are intended to improve their usefulness or at least not to impair it. Proceeds from cuttings are regarded as reducing operating expenses or as incidental receipts. Since the profits from protection, recreation, and wildlife forests are largely of an indirect or social nature, these forests are more often public than private ventures. Obviously, therefore, it is difficult to discuss them in financial terms, but it is still possible to consider the economic factors underlying each of these uses.

1. PROTECTION FORESTS

A. Functions and Classifications. All forests have some protective value, but protection forests, as such, are those whose primary function is (1) to protect other lands against damage (direct or indirect) from erosion by wind or water, flooding or covering by silt; (2) to conserve water supplies and to assist in preventing their pollution. These purposes frequently are combined although one objective is likely to be uppermost in importance in a particular forest. Regardless of the type of protection they afford, forests fall into three economic classes, based on the nature and value for other purposes of the land on which they lie: (1) those on land of such poor quality and situation as to have little or no commercial value; (2) those on lands useful only for forests that are themselves suited to commercial-timber production; and (3) those on lands having one or more non-forest values.

Class 1 lands cover enormous areas in mountain and semi-arid regions of the West, where the maintenance and establishment of protection forests are often the keys to controlling erosion, preventing floods, and conserving water for irrigation and other uses over large

areas of lowlands, near or remote (Chapt. IX, Sec. 6*A*). Class 2 lands lie mostly in more humid regions where soil and moisture permit growth of commercial timber (Fig. 15). Class 3 lands consist primarily of those surrounding public water supply reservoirs in the vicinity of large cities. Frequently they have an agricultural or residential value and, generally, like Class 2 lands, will also produce commercial timber. The boundaries of these classes are subject to changes, owing to shifts in the value of forest products (Chapt. XIII, Sec. 4) and in the demands for land for other purposes.

Protection forests do not necessarily require exclusive use of land, provided the other uses do not destroy or seriously impair their protective value. Thus, if the forest is suited to grazing, this may be allowed if it is not extensive enough to expose the soil to erosion or to damage the forest (Chapt. I, Sec. 6). If it is suited to recreation, this may be permitted except on watersheds of public water supply reservoirs where danger of pollution usually makes it unwise. If physical and economic conditions are favorable timber-production forestry is also possible, provided the methods used in cutting do not open the soil to erosion.

B. Ownership. Since protection forests are essentially a form of insurance on values of land and other property, expenditures to attain this end should bear a relation to the value of the property to be protected and the degree of hazard involved (Sec. 1*C*). Because the forces of erosion, falling water, and wind do not respect property lines, either the cost to the individual owner, unless his boundary has the correct relation to topography, is prohibitively expensive or the protection itself is physically impossible. A hillside farmer, if he can stand the expense, may protect his fields by installing ditches and check dams, but his neighbor in the bottom lands can do nothing to prevent flood damage caused by forest destruction on the headwaters of a stream 500 miles away.

For this reason the problem in its major aspects is left to the public. It requires either public ownership or public control (Chapts. XX and XXI) over the lands which must be forested or kept in forest to afford widespread protection. When such lands belong in Class 1 (those without direct economic value), the logical solution seems to be public ownership. The same is true of expensive lands surrounding municipal reservoirs in Class 3. Since timber-production forestry is an economic possibility on Class 2 lands, public action seems to be required only when the owners manage the forests in a way destructive to their protective quality or only if some special type of protection is needed.

Privately owned protection forests are chiefly those belonging to water supply and power companies. Since these are public utility enterprises, sometimes they are given the power of eminent domain (Chapt. XIII, Sec. 3) to obtain the land they need.[1]

C. The Valuation of Protection Forests. The financial problems revolving around protection forests are to determine (1) the value of the property to be protected; (2) the cost of acquisition, developments, and maintenance of the protecting forest; and (3) the possible direct return from it.

The two properties, protected and protecting, must be regarded as one economic unit, and all questions of costs and values must be figured on the basis of both. This can be demonstrated by the use of an oversimplified case.

Assume: (1) A farm stretching along the side of a steep ridge in a narrow belt, immediately above which is a narrow belt of forest running to the top of the ridge. The soil of both is highly erodable; both farm and forest have the same area. (2) The forest is entirely noncommercial, and the land on which it lies is incapable of producing any direct revenue. (3) There is no organized fire protection in the region, and owner of the forest will not cooperate in fire protection or even permit the owner of the farm to enter and protect his own property. (4) The fire hazard is very high, and a single fire will destroy the forest completely, after which the first rain will start erosion and immediately destroy the field below. (5) The farm yields an average annual income of $4.00 per acre, which at 5 percent gives a capital value of $80 per acre (Chapt. VI, Sec. 8*I*). (6) The farmer can protect the forest from fire if he gains the right to do so without added expense to himself, and the taxes are inconsiderable.

Question: How much can he afford to pay (1) for an annual lease of the forest or (2) to purchase it outright, to insure the earning power and capital value of this farm? If he leases, he reduces his profit. If he purchases, he not only reduces his profit but also increases his investment. The question boils down to how much profit he can afford to sacrifice to be sure of drawing the remainder. If he is entirely dependent on his farm, this will be where the income balances his living expenses. If he can live on $3.50 per acre per annum, he can afford, in theory, to spend $0.50 per acre annually to insure his livelihood. Assuming that he can lease the forest for that amount an-

[1] Individual private owners, of course, may have protection forests in the forms of windbreaks, woodland strips along streams, and so on, but the economic issues involved are not large.

nually, he should be able to purchase it at the capitalized value of this sum, which at 5 percent would be $10 per acre. If he does purchase, he doubles his acreage without increasing his yield. In effect he is raising the same amount of crops on two acres as he did formerly on one, the two acres taken together being worth $90. His rate of profit, which was assumed to be 5 percent when we chose this figure as the discount rate, has now dropped to 3.88 percent. In other words, his insurance has cost him 1.12 percent of his annual profit.

The problem presents itself, in terms of possible loss in water storage due to silting up of its reservoir, to a large power company that is proposing to build a dam in a region where erosion is a serious menace. If the shed is unforested, how long will it be before the reservoir is silted up and useless? Assume this to be 50 years; the question becomes: Can the investment be amortized (Chapt. VII, Sec. 6) in that time? If not, what will be the added cost of purchase and forestation of the watershed to protect the investment at least until it can be? If the shed is already forested, how much will insurance in the form of forest-land purchase plus maintenance and taxes amount to in order to prolong the earning power of the investment? [1]

If the company supplies water to a city in a humid region, the problem generally is one of protection against pollution rather than erosion. This can be prevented either by purchasing a large land area and putting or conserving it in forest [2] or by building expensive filtration plants. Which will be the cheaper in the long run?

Although these companies consider the costs of land acquisition in the above terms, naturally the figures obtained will not be related to what they have to pay—that depends on the scale of land and sometimes on timber values prevailing in the region. It is likely to be higher for water companies operating in humid regions in the East, where land has other uses besides what it has in the semi-arid regions of the West.

Companies seldom are enthusiastic about making these large investments and frequently welcome public forest-acquisition programs, which relieve them of the necessity but, for ovious reasons, prefer to own the land on which their reservoirs and dams are located, plus an additional area to control ingress and egress to them. They also desire to own water rights on the sheds from which they draw. Where

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[1] W. W. Ashe, *Financial Limitations in the Employment of Forest Cover in Protecting Reservoirs*, United States Department of Agriculture, Bulletin 1430, Washington, D. C., 1926.

[2] Provided the public is excluded from it.

public forests exist, the public is generally loath to relinquish either land or water rights. Consequently many battles have resulted between public and private interests.

The valuation of lands for public forests for general protective purposes, such as on the headwaters of navigable streams, cannot be worked out entirely in terms of property or income losses on insurance principles. The figures involved are too vague, and acquisition programs are bound up with questions of public policy. Discussion is therefore deferred to Chapter XX, which deals with public forestry.

D. Forestry Costs. The costs of protection forestry depend on the overhead in the form of taxes, interest, and administration; the operations cost of patrol, protection, and so on; and the degree to which costs may be reduced by returns from forest operations, such as sale of timber and leasing of grazing or recreation privileges. The higher the value of the land, the higher the overhead in taxes and, probably, the interest charges until the investment cost is paid.

If the forest is in condition to afford adequate protection when acquired, the operations will not require further expenditure than is necessary to protect it from fire and other forms of damage. If the land, when taken over, is unforested, a forest must be established. If, as sometimes happens on unforested land, erosion is serious, considerable expense may be necessary to install erosion-control works, such as check dams and ditches, before forestation is possible.

The extent to which it is possible to reduce the cost of holding land for protection forests depends on how much revenue can be obtained from them. In regions of good forest soil and market conditions, the opportunities may be good (Chapt. XIX, Sec. 4*C*). Where the forest is non-commercial and not suited to grazing or other secondary uses, they are poor.

2. RECREATION FORESTS

In recreation forests the sole or primary use is for outdoor recreation. Treatment consists of: (1) cultural measures to maintain or increase the aesthetic appearance of the forest; (2) its modification by cutting vistas and opening lookout points; (3) installation of necessary protective works to prevent damage from fire and other agencies; and (4) construction of roads, trails, camping and picnic places, and occasionally more elaborate facilities, as artificial lakes, beaches, and special structures of various kinds.

The intensity of treatment depends on the funds available, the amount and nature of human use, the degree of hazard, the character of the forest, and the theory of the management on what constitutes

an ideal forest from a recreational and scenic point of view. Consequently there is great variation in the amount and type of development. It varies from areas where "it takes a constitutional amendment to cut a tree and a revolution to build a road" to areas where sight of the forest element is almost lost in the building of a multiplicity of recreational structures of a nature entirely inconsistent with a forested environment. On the other hand, sometimes the forest itself is given intensive treatment by the introduction of exotic species and flowering plants, best described as forest gardening.

A. Economic Aspects of Park and Recreational Forests. Recreation forests may be classified economically as: (1) private forests maintained for a financial profit from the sale or rental of recreational facilities, such as forest areas serving as settings for summer hotels; (2) luxury forests[1] for the recreation of the owners and their guests (Chapt. IX, Sec. 5*C*); (3) public forests wholly set aside for public outdoor recreation. They are a special form of public park, often called forest parks. Although they have certain peculiarities, their economics do not differ greatly in principle from those of large-scale parks[2] in general.

This chapter is concerned chiefly with public recreation forests, and so the word park is often used to describe them. Their major purpose is social rather than economic—or at least regarded as social because of the difficulties in reducing their profits, which are in various forms of human welfare, to monetary terms (Chapt. VIII, Sec. 1).[3]

If we cannot measure the economic value of parks to the users, such areas produce a more or less measurable economic effect on the community where they are located. On its positive side this effect may represent an economic gain due to (1) enhanced value of property surrounding the park, (2) business brought into the neighborhood or community as a result of the presence of users, and (3) salaries and wages of park employees (Chapt. IX, Sec. 9*C*). If the park does not increase the value or economic usefulness of the surrounding land or if it occupies land of high earning power, put to other use, these re-

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[1] Thorstein Veblen, *The Theory of the Leisure Class,* The Vanguard Press, New York, 1899, would consider large areas of this nature as examples of "conspicuous consumption."

[2] For an excellent specific study of park economics see H. H. Chapman, 1938, *Shall Our State Parks Be Self-Supporting?* Publication 38, Connecticut Forest and Park Association, New Haven.

[3] See P. V. Brown, *Journal of Forestry,* Vol. 39, No. 6, p. 536, June, 1941, for a somewhat different point of view.

turns may not offset the loss and, leaving social gain out of account, the park may be an economic liability.

These factors must be considered in all park-acquisition programs. From a bookkeeping standpoint, the results are never conclusive because social value must always remain an *x;* nevertheless, they are important, the more so when the park is of a type that draws most of its users from other communities or even from regions, as do national and often large state parks (Sec. 2*C*).

Another economic aspect of parks is their cost in terms of investment and operation charges as compared with the number of users. Is a park which costs $1 million and caters to a million people a year who remain on an average of only 2 hours more or less valuable than one which costs $100,000 and caters to 5000 visitors who remain for an average of 3 days or a week? Their relative costs per user may be calculated in terms of park days—one day's use for one person—but the comparative social gain can be guessed only in terms of a preconceived social theory as to the class of population it is to the best public interest to serve and the type of recreation which will give the greatest benefit.

An obvious answer to the whole question is generally that "public outdoor recreational facilities of a wide variety of types should be available to all classes of the population." This statement gives no measure of how much a particular community should spend for this purpose. The general consensus among experts seems to be that the larger the community and the greater the proportion of its inhabitants in lower income groups, the greater the need for such expenditures. Full discussion lies outside our scope, but it is worth noting that forest recreational areas probably cost less per acre to acquire and administer than parks of almost any other kind because generally they must be located on areas at some distance from centers of cities and on land which often is not, as park lands go, particularly expensive.

A frequent question in park economics is the extent to which their capital costs and operation expenses may be met by admission and various special-use charges, as highway bridges often are paid for by toll collections. Perhaps the theory is sound that public improvements, used only by a portion of the public, should be paid for by the users; nevertheless, as applied to parks, it might well nullify their social value because the charges would have to be too high for those most in need of using the park. The charging of fees for special services which are sufficient to meet the cost of park operation is another matter and, if the fees are reasonable, is probably sound. It costs the state park authorities so much to operate a ski jump. Only a

small portion of park visitors will care to risk their necks. Why not let those who do, pay the state for its trouble? The questions of charges for park use are, after all, policy questions and usually are decided on the basis of the public's willingness to tax itself for expansion of public recreational activities.[1]

B. Acquisition and Development Costs. Recreation forests generally cost more to acquire, develop, and maintain than other types of forests, both because they usually require lands better situated in relation to population centers and because better-timbered and more generally scenic lands are sought. Prices paid are dictated, in the last analysis, by the public's desire for the land and by the relative bargaining position of administrative agencies in reference to private owners (Chapt. VIII, Sec. 1*A*).

Development costs fall into two groups; those having to do with the forest itself and those connected with the structures necessary to make it available for the users. Discussion of the latter group belongs to the landscape architect and the park engineer. The protection cost is certain to be higher than on other forests of a similar nature but having a different purpose, because the intensity of human use increases fire hazard and introduces the hazards of destroying reproduction, compacting the soil, and working general damage. The more the forest is used, the greater these hazards become and the more protection costs. One patrolman per 1000 acres may be ample in a timber forest; a recreation forest may need 10 men to the 100 acres on a Sunday afternoon in the fire season.

Costs of stand improvement are what the management chooses to make them and vary with its ideas of what constitutes an aesthetically satisfactory forest, as described in the introduction to this section. Landscape thinnings generally are more costly acre for acre than regular forestry thinnings. Five man-days' work may be sufficient for a commercial thinning in young second-growth hardwoods; 15 more might not be enough for landscape treatment on the same acre. Although it is quite possible to obtain incidental revenue from the sale of materials removed in landscape cuttings, park authorities seldom do but frequently utilize the timber that is removed for park purposes.

C. Park versus Forest. The mere demand for recreational forests implies that forests have become scarce to some degree and that so-

[1] Methods of handling receipts from park charges of this nature were referred to in Chapter III, Section 8*A*.

ciety has reached a stage of social development where the need to set aside some forest areas for this purpose is acknowledged. However, attempts to devote huge forest areas to this exclusive use raises the issue as to whether the direct economic loss occasioned by taking them out of production as sources of raw material and as suppliers of labor and investment opportunities is economically or even socially justified.

When it is a choice between a temporary timber-mining economy and a permanent recreational one, doubtless the latter is socially and economically preferable, but the relative advantages of an economy based on permanent production and of a recreational one can be discussed intelligently only with reference to particular areas.

Frequent clashes result between partisans of national parks and advocates of national forests. In the attempts to force public acquisition of private forestry operations, disputes arise between organizations favoring state parks and those advocating state forests. Controversy all too frequently is between groups with preconceived points of view, unwilling or too illy equipped to make the necessary impartial economic and social studies to throw light on the matter.[1] Those favoring recreational use sometimes fail to distinguish between timber-production forestry and timber mining or to realize that recreation may also be obtained in timber-production forests. Those thinking only in terms of timber values may have an inadequate conception of intangible values of recreation and thus fail to realize its social importance.

Decision should rest on: (1) the relative long-range economic advantage to the community in which the forest lies of an economy based on recreational use as compared with one based on permanent forest production (Chapt. IX, Sec. 5*B*); (2) whether the area is one where social values would be destroyed by the type of cutting that timber-production forestry implies or one which, by judicious management, can be developed for both economies without material loss to either but with a corresponding gain to the community.

Point 1 assumes that the area will be used for recreation if set aside for that purpose. Since every forest may have some recreational use (Chapt. VIII, Sec. 1*A*), the question, How much will it be used? must enter. The extent of such use will depend largely upon accessibility, degree of development, and the amount of advertising it receives and will change with economic conditions and popular attitudes toward

[1] A few excellent studies of this nature have been made, one of which is the "Cascade Mountain Study," by the Washington State Planning Council, Olympia, 1940.

"the great outdoors." Areas located a great distance from centers of population will be the soonest affected. These considerations make it advisable to take into account probable future populations and income trends in establishing forest parks (Chapt. XII, Sec. 2).

Point 2 concerns the loss of other resources by reserving forests exclusively for recreation. Both points have to be considered in the light of the size and value of the areas involved. In relatively small forest areas, such as might be made into municipal or county parks, the economic advantages of practicing timber-production forestry would be small, perhaps not worth considering. The issue more frequently is between their use for public or private recreation, the latter generally taking the form of luxury forests surrounding residential property (Chapt. IX, Sec. 11).

As between state forests and state parks, the issue presents itself in two forms: (1) relatively small bodies of virgin or mature timber; (2) larger areas of cutover or second-growth forest. In the first the recreational value, not to mention the scientific value, of such stands frequently overshadows the possibility of economic return, even from a long series of crops on the same area, and justifies their preservation as "park areas," although the fact that they may be as effectively destroyed by the trampling feet of many recreationalists as by the axes frequently is forgotten.

As to the second-growth forests that cover great sections of the eastern states, the immediate economic value of which is small, the point of view frequently is expressed that park usage is preferable because it can be made an economic asset to the locality almost immediately. As the forests mature, this temporary gain may become a loss because the new forests cannot serve as the basis for new industries. The recreational economy of such regions is largely seasonal and may be incapable of adequately supporting the permanent population (Chapt. IX, Sec. 5) which in consequence lives on a low economic level and tends to become somewhat parasitic. The Adirondack and Catskill parks in New York state (Chapt. XX, Sec. 2*C*) are examples. Opening them up to rational cuttings under forestry practices would go far to remedy a present situation apparently destined to become worse.

The most important and acrimonious disputes between park and forest advocates center around the national forests and parks. The earlier national parks were established not as parks in the sense of ordinary recreational areas but rather as preserves of unique scenic and scientific interest. Partly as a result of this quality and partly owing to the combination of the development of automobiles and a

great extension of the national income commencing about the time of the first World War, they developed, perhaps contrary to the intentions of their founders, into great public playgrounds. The enormous influx of visitors proved a bonanza to concessionaires and to the merchants of surrounding communities. National parks became big business. This led to the demand for their establishment in other communities, both by those who would profit commercially from them and by those interested in public recreation.

Unique scenery, such as provided by Yellowstone, Grand Canyon, and other earlier national parks, is rare, but magnificent forest scenery is still available. It is not surprising that park enthusiasts little heeded whether a forest was under public ownership as a timber-production forest or in private use for the same purpose or whether it was already used for public recreation but was not called a park. Organized attempts were made to shift from one sort of constructive use to the other without consideration of ultimate social and economic values.

The original ideal of a national park is based on the paramount importance of social, we might almost say spiritual, values. This ideal precludes any form of commercial activity not connected with park use. Thus any enterprise, public or private, such as a water-storage reservoir, an electric transmission line, interior private holdings used for residential, agricultural, or grazing purposes, or even a public road to facilitate general as distinguished from park traffic, must be excluded.

Neither public nor private forests that are producing timber require or necessarily would profit by such exclusions. In many parts of the country, particularly in more mountainous regions, the economic and physical structure of the terrain is so closely interwoven that to preclude all such activity in one place would seriously cripple economic development in surrounding areas. There may be only one valley in a given region where it is possible to create a storage reservoir necessary to irrigate a whole county. If it is constructed it will transform an arid desert into an agricultural region (Chapt. IX, Sec. 6*A*). The closing of summer grazing ranges in a mountain park may render the winter ranges, lower down the mountain, useless (Chapt. IX, Sec. 6*C*). The closing of forest-products establishments means loss of employment opportunities (Chapt. IX, Sec. 12). Hence the creation of a national park in place of a national forest is more than a question of whether a given forest area should be treated as a perpetual source of timber or as a scenic reserve; *it is one of the economic welfare of the surrounding region.*

If, to save the economic welfare, compromise is made with the national park ideal to permit construction of reservoirs, grazing use, and public road construction, there seems little argument for not making economic use of timber resources on a constructive basis. If the ideal is retained, it must be demonstrated that the spiritual values of the park are sufficiently important to the people of the whole country to justify the economic loss to those in the region in which it lies, even though the park itself may be economically advantageous to some local groups. In many doubtful cases the solution can be worked out best in terms of multiple use, the economic factors of which are discussed in Section 4.

3. WILDLIFE FORESTS

A wildlife forest is one where the primary objective is the production of the maximum population of wildlife of one or more kinds of forest animals or birds, usually of game species. Such forests may be maintained for hunting or treated in whole or in part as wildlife sanctuaries where no hunting is allowed. They may be owned either privately or publicly. If privately owned, they are maintained occasionally for profit either from the lease of hunting privileges or from the sale of game after it has been killed, or they may be maintained on a luxury basis by wealthy individuals or game clubs and then usually are called hunting preserves. Except in those unusual instances where they are maintained for the production of game sold after it is killed, wildlife areas are a highly specialized form of recreation area. Any forest may be set aside as a wildlife forest, but to produce the maximum amount of game, the stand usually must be given special treatment. The discussion which follows presupposes such treatment and is not concerned with such woodlands not under management for a definite objective which the owner may use primarily for hunting grounds.

The ideal forest, from the wildlife expert's standpoint, is one that contains a maximum number of plants which produce herbage, browse, berries, or nuts, according to the food requirements of the game species in which he is interested. Also it must have cover, in the form of vegetation, that shelters game from inclement weather, facilitates its escape from predatory animals, and provides it with suitable breeding places. Many of the plant species best suited to these purposes are shrubs or secondary trees, often of little or no commercial value and frequently of no particular landscape interest. Therefore, the wildlife expert is concerned primarily with species different from those usually regarded as important in forestry. Indeed, he regards the

high forest which, in one way or another, is the objective of both the "commercial" and the landscape forester, as more or less inimical to his purposes, since it tends progressively to exclude the subordinate vegetation essential to a large game population. It is well known that there is more game in open-grown second-growth forests than in primeval forests.

The objective of the wildlife technician is obtained, as in other forms of forestry, by the removal of species and individuals which he does not desire and by the introduction and encouragement of those he does. His task, in the long run, is more difficult in regions which are climatically favorable to true forests because the species he desires the most are usually the shortest lived and are soon crowded out as the stand advances in age and density. In such regions, in fact, he is working against nature, whereas in other types of forestry one works more or less with nature.

In regions such as the Scotch Highlands where the vegetative type is a form of low cover that maintains itself against the true forest, the task of the game expert is much simpler and less expensive. In the eastern United States where the forest sooner or later will dominate and practically exclude vegetation favorable to game, the application of the game forester's technique is bound to be expensive because it never ends.

The western forests, in general, are much less dense even at maturity than the eastern ones, and the game species there are mostly large herbivorous mammals which can subsist in numbers on forage and browse that normally are more or less abundant. Therefore, their maintenance problem appears to be less difficult technically and much cheaper economically even though the segregation of large areas of forest to wildlife production, to the exclusion of grazing by domestic animals, creates an economic issue similar to that discussed in connection with park versus forest use in Section 2*C*.

An economic study of wildlife forestry when practiced on a large scale, which at the same time has an intensive basis in forests actually or potentially of commercial value, or perhaps combined with other forms of recreational value, requires an answer to such points as: (1) the potential loss in valuable wood products, labor, or other opportunities; (2) the cost of production per unit of game produced; (3) the consideration of whether an equal amount of game might not be produced more cheaply from larger areas of land also producing timber. (Under timber-production forestry, reproduction cuttings and thinnings occur regularly so that there is always some land in a condition well suited to game.)

As applied to public areas, the question might also be raised: (1) whether enough game could ever be produced, even under the most elaborate technique, to satisfy the demands of all the hunters desiring to use it; (2) whether the general public in the long run would be willing to meet the costs of a program which attempted to do so (however large the number of sportsmen, they are only a minority of the population); (3) whether, if the attempt was made to pass its cost to hunters in the form of extra license fees or of taxes on kill, the cost would not be so high as to exclude an undue proportion of sportsmen.

As yet too little is known about costs of such enterprises to attempt to answer these questions, but, if the wildlife movement grows, answers will become necessary although, as in park work (Sec. 2*A*), there will always be a social value x. What is the recreational value of a ruffed grouse to a hunter?

4. ECONOMIC ASPECTS OF MULTIPLE USE

With a sufficiently broad point of view and with a sound technical knowledge, properly coordinated, it usually is possible to combine recreation, wildlife, and timber production in the same forest, provided it is big enough (Chapt. I, Sec. 4, and Chapt. IX, Sec. 5*D*). However, it cannot be done without some loss of economic return from wood products, some decrease in amount of wildlife production, and some impairment of recreational values, plus a greater cost of administration. No amount of technical skill or expenditure of funds will make it possible to obtain maximum production of timber, recreation, and wildlife, or even any two of them, from the same piece of land, any more than one can obtain maximum production of both corn and wheat by sowing them on the same acre at the same time.

When one usage is of paramount social and economic importance, the other usages should not be allowed to handicap it by reducing its output. Otherwise, on all public forests each should receive a proper share of attention according to circumstances. Sound administration and properly coordinated development can be obtained under multiple use only when the proportionate value of each is clearly defined, planned for, and not changed frequently. Multiple use, badly planned and incompetently executed, can wreck a forest almost as effectively as an old-fashioned lumber operation. One purpose, well executed, will serve society better than three incompetently managed.[1]

[1] See also Chapter XX, Section 4*J*, and G. A. Pearson, *Journal of Forestry*, Vol. 38, No. 3, p. 261, March, 1940.

CHAPTER XVII

FOREST TAXATION, TARIFFS, AND INSURANCE

In Chapter XIII, Section 5, the importance of land taxes in the cost of raising timber was shown. This chapter extends that discussion and suggests methods of reducing the forest tax burden. Tariffs seldom affect forests directly, but often influence the distribution of their products. Insurance is not a tax, but the difficulty in writing it on forests is an obstacle to forestry.

1. THE TAXING POWER

Taxes are an overhead cost of living which neither producer nor consumer can control or escape. Everyone pays them directly or, indirectly, through price increases. Without taxation, neither governments nor organized societies could exist. Even under socialism the government would have to charge extra for its goods and services to build roads, support schools, and hire policemen.

The taxing, next perhaps to the military, is the most formidable of governmental powers. It is two-edged. Wisely collected and efficiently spent, taxes build up the community and increase the welfare of the taxpayers. Arbitrarily or dishonestly assessed, in disregard of taxpaying ability, and inefficiently spent, they reduce individuals and societies to poverty.[1] This far-reaching power may operate by intent or by accident to regulate the use of property, control trade, and alter living conditions. The taxes on the corner lots at Broadway and Main Streets are sufficient to prevent the properties' being used for anything but business purposes. A heavy tax on the production of the copper mines of one state may shift production to another state, even though the ore is less rich, where taxes are low. The old European luxury tax on windows kept people of low income living in darkness and ill health. Taxing blank walls would let in light and promote health. Governments may use taxes to extinguish business they consider undesirable. The classic American example is the fed-

[1] Germany, by using her present military position in the occupied countries of Europe to collect exorbitant taxes, is reducing large groups of the population to starvation.

eral tax on state bank notes, which is so high that no state bank issues any. Conversely, by not taxing or by taxing very lightly educational and religious institutions, America tries to aid them.

No individual or group pays taxes for the love of it; each tries to shift the load to others—industrialists to farmers, residents to non-residents. Communities compete to secure the major portion of the taxpayer's dollar. If a group or jurisdiction controls the taxing power, it is in a position to enrich itself but invites destruction if it goes too far. Many armed revolutions have resulted from abuse of taxation. The framing of tax laws which are just to all, provide for all legitimate public needs, and neither overtax nor undertax any particular type of property or person is exceedingly complex. This is particularly true for forests. Present forest taxation is, to say the least, unsatisfactory and needs revision.

2. KINDS OF TAXES

Taxes may be classified as property, income, consumption, and miscellaneous.

A. Property Taxes. These taxes are levied on property according to its value. They may be *general*, covering all property, even handkerchiefs, or *specific*, covering certain kinds only. Most American property taxes are general,[1] but, owing to the difficulty of locating and valuing small and movable personal property, usually are collected only on real property, that is, land, buildings, and larger and more valuable personal possessions, as furniture and automobiles.

The tax is a percentage of the value of the property (Sec. 5), called the *tax rate*, which generally differs among communities and sometimes with different kinds of property, but the rate does not generally change with the value of the property.

B. Income Taxes. Income taxes are collected not on what the taxpayer owns but on his income, *net* or *gross*. A gross income tax, unless the rate is very low, may be a serious matter for the taxpayer because his gross income may have little relation to his real earnings. Most income taxes are net; the rate usually rises with the income. Very small incomes often are not taxed either because the people involved cannot stand even a small tax or because the amount obtained is less than the cost of collection. By changing the exemption limit

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[1] Except as certain classes of property, such as a mechanic's tools, may be legally declared non-taxable.

and the tax rate on different-sized incomes, an income tax may be made to bear more or less heavily on different income classes.

C. Consumption Taxes. Consumption or *excise* taxes are levied on the production, importation, sale, or purchase of an article or service. When confined to expensive or unnecessary articles, they are called luxury taxes. Internal revenue taxes on liquor and tobacco are given this title regardless of the feelings of consumers.

Consumption taxes may be levied on the producer, importer, wholesaler, retailer, or ultimate consumer. The tobacco manufacturer must pay the federal internal revenue tax, the importer the tariff, and the driver has the gasoline tax added to his bill at the filling station. Eventually all are paid by the final consumer because the tax is added to the purchase price whether he knows it or not. Applied to food and ordinary clothing, particularly at high rates, consumption taxes bear very heavily on the lowest-income classes.

Tariffs and severance taxes are consumption taxes of interest in forestry and the forest industries. Tariffs are taxes on goods transported from one country to another (Sec. 12). A severance tax (Sec. 11) is one levied on a natural resource when it is removed from the earth, as a tax of so much a ton for coal mined. The theory of severance taxes is that once the resource is removed it cannot be reproduced, and the community is entitled to a revenue from it before it is too late. Such taxes on timber superficially resemble yield taxes, an often advocated form of forest taxation (p. 345).

D. Miscellaneous Taxes. There are various other sorts of taxes, such as fees or licenses [1] for the ownership of certain kinds of property, like automobiles, for engaging in certain kinds of business; payroll taxes and taxes on inheritances of property. Of all these taxes, however, only inheritance taxes have specific influence on forestry (Sec. 12) even though the forest owner may have to pay some of them in his business operations.

3. TAXING UNITS

In the United States every political unit from the federal government to the country school district has the power to levy taxes. There are about 75,000 taxing units in the United States. All are limited by constitutional provisions and laws and by practical con-

[1] Whether fees and licenses are, strictly speaking, taxes need not concern us here; the payer regards them as such, and they have the same economic effect on him.

siderations in the kind of taxes they use, the way they assess them, and the money they can raise from them.

The federal government collects no property taxes, using instead income and consumption taxes. Originally the bulk of its revenues came from tariff duties and internal revenue taxes, the latter chiefly on tobacco and liquors. Today its largest source is the income tax. The total tax receipts of the federal government in 1938 amounted to approximately $6 billion.[1] How many billions it will be before the second World War is over no one knows.

The states rely chiefly on property and consumption taxes although about half of the states also have income taxes. In 1932, the total tax receipts of the states amounted to approximately $2.208 billion, of which $323.477 million came from property taxes, $979.385 million from consumption and similar taxes (chiefly gasoline), and $47.852 million from income taxes.[2]

County, township, municipal, and other local taxing is regulated by state laws that prescribe the taxes to be used, the methods employed for collection, and the purposes for which they may be spent. The states usually require that a certain proportion of the local taxes be turned over to them for state purposes. Local governments are therefore the chief recipients of property taxes, and it is with county and township taxes that we are chiefly concerned in discussing forest taxation.

The supreme importance of property taxes in local government is indicated by the fact that in 1932 approximately two-thirds of their total tax receipts of $4.7 billion came from property taxes. The total American tax payments in 1938 were about $17 billion,[3] amounting to 26 percent of the national income for that year (Table 17). Under present war conditions the percentage is much higher.

Tax receipts may go into a general pot to be used as needed according to budget or other requirements, or they may be collected for specific purposes. Taxes for general purposes are the more common. Examples of special-purpose taxes are: state gasoline taxes, generally set aside for highway purposes, and those taxes assessed on forests for protection purposes (Chapt. II, Sec. 3*B*).

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[1] Annual report of the Secretary of Treasury, *State of Finances*, 1938.

[2] United States Census Bureau, *Financial Statistics of States and Local Government*, p. 7, 1935.

[3] National Industrial Conference Report, *Economic Record*, August 31, 1939.

4. TAX ASSESSMENT AND COLLECTION

Taxes may be based on value (called *ad valorem* taxes) or on quantity (called *specific* taxes). When levied on quantity, the lower the value the higher the tax. Thus a \$0.03 gasoline tax is at a higher rate when the price is \$0.15 than when it is \$0.25. Under the property tax, the basis is value. However, where land values run rather uniformly, the tax may be set at so much per acre on an average valuation. Taxes on value may be levied in terms of a percentage or in mills per dollar, one of course being easily convertible to the other. Thus a tax rate of 15 mills or \$0.015 per dollar amounts to 1.5 percent. Property tax rates are usually stated in mills; income taxes in percentages.

The levying of a property tax involves a determination of the value of the property to be taxed and of the rate of taxation. Tax laws require valuation to be determined by public authority or require that the owner's valuation be approved by the authority. The basis is supposed to be what the property would bring if sold under conditions other than a forced sale. This assessed value (Chapt. VIII, Sec. 1*B*), therefore, is often referred to as sale value.[1] The officials, making the valuation, are called *tax assessors.*

The major key to just taxation is correct valuation; overvaluation is unfair to the payer; undervaluation, to the community. Yet large items of property seldom sell frequently enough to establish definite market values; so assessed value amounts in practice to what the assessors think the property ought to sell for, based on the sales records available, and may be wide of the mark. Pressure on the assessors often results in lower valuations than conditions justify; its absence, in higher ones. Whatever the assessment, the owner, feeling himself aggrieved, has the right of appeal to a disinterested board that has the power to reassess the property.

The tax assessors have nothing to do with setting the tax rate; that is done by other officials. The procedure is to estimate the sum necessary to run the town, county, or other taxing unit and to divide it by the total value of all taxable property, thus determining the rate. Suppose that the total assessed value or *grand list*, as it is often called, in a country school district was \$100,000 and that the trustees estimated the cost of running the little red schoolhouse at \$2000; the tax rate would be 2 percent. It is evident that, if the valuation had been

[1] Sometimes tax laws require assessment on a fixed portion only of the "full value." This means in practice simply that the rate must be higher.

$50,000, the same amount could have been raised by using a 4 percent rate or, if $200,000, a 1 percent rate. Consciously or otherwise, the local practice may be to overassess or underassess property; hence it is necessary to know which is the custom before a tax rate can be characterized safely as high or low. Tax collection is by officials not connected with assessment. State laws regulate the length of time for payment and the rate of interest charged for neglect to pay on time. Failure to pay within a given term of years results in forfeiture of the property to the community.

The taxable wealth of a community is often referred to as its *tax base,* perhaps with a descriptive phrase, as "a tax base largely of agricultural and forest property." The size and form of this base determines the practical limit of taxation.

In the next group of sections we discuss the relation of various kinds of taxes to forestry and the forest industries, giving our chief attention to the property tax which is the most important.

5. FORESTS AND THE PROPERTY TAX

All private and some public forest land (Sec. 9) comes under the property tax.[1] To understand its effects one must study its theoretical aspects and observe its practical working.

A. Theoretical Aspects. One of the keys to understanding forest taxation is the relation between property and income taxes. Assume that a wheat field produces $50 net per annum; if it is capitalized at 5 percent of its value, the amount is $1000 (Chapt. VI, Sec. 8*I*). At a property tax rate of 1.2 percent, the tax is $12. A 24 percent net income tax on the $50 would also be $12. Hence it should make no difference to the owner or the community which tax is used. But the example is unrealistic. The field would not produce the same income annually. The income would vary with the crop yield, the price of wheat, and the labor cost. Therefore valuation should be on its average net yield. This done, the fixed relation between the two taxes is destroyed.

An individual may not complain if his taxes are higher in the fat years than in the lean ones, but a community needs a fairly stable flow of tax receipts. Therefore it depends on property taxes based on valuations which, because of the law of averages, fluctuate less than incomes. Furthermore, under an income tax, non-revenue-producing

[1] Except as it may be exempted by law, which is unusual in forests.

properties would be tax free, yet the community must furnish public services for their owners.

As concerns forests, non-producing lands fall into four classes: cutover and immature land; mature but inaccessible timber; immediately merchantable timber held for speculation; forested estates held for recreational purposes. Classes 1 and 2 can produce an income only when the forest becomes mature or economically accessible (Chapt. X, Sec. 2), but those in Classes 3 and 4 can produce an income any time the owner desires. Could he not cut the timber and sell or rent the estate?

From a taxation viewpoint, cutover and immature forests are the most important. It is evident, after a moment's reflection, that the great majority of forest lands always must be in this deferred-income class. Under the universal practice of sustained-yield forestry, on a 60-year rotation only 1.6 percent of the forest area would produce an income in any one year—neglecting thinnings and incidental receipts.

Since the key to a just application of the property tax is sound valuation (Sec. 4), what is the tax-valuation problem in young forests? Theoretically it is simple. Discount all future net yields to the present (Chapt. XIII, Sec. 6); thus determine their present value and tax them accordingly. However, this method values the land for timber growing but takes no account of the timber on it at the moment. This also is taxable. Its value increases from zero after a clear cutting to maturity, when it is several times that of the land itself. The value of young timber may be determined by discounting its maturity value. The total value of the property is the sum of the two, land plus timber (Chapt. XVIII). Useful as it may be as a guide (Chapt. XIII, Sec. 6), this method falls down because of lack of data on future values and is beyond the mathematical understanding of the average assessor who must fall back on such sales data as is available. Purchases of cutover lands and immature timber are infrequent and usually made as a speculation rather than as purchases based on knowledge of future values. So their tax valuation is, regardless of method, a matter of guesswork.

Only one thing is sure: As the crop grows it increases in value so that, whatever the valuation, the assessor is justified, indeed by law required, to increase it progressively as the crop approaches maturity. *Consequently the owner is not only carrying a pyramiding load from interest charges on his past taxes* (Figs. 42 and 43), *but his current tax bill may be increased annually or periodically, and, long before his forest yields an income, the tax load becomes formidable* (Sec. 6).

Under sustained-yield forestry the property produces an annual income; taxes are in effect an operation rather than an investment cost (Chapt. XV, Sec. 5), valuation can be based on average annual income, and the objections to the property tax as such disappear. Sustained-yield forestry is as rare as it is desirable; yet the property tax on young forests appears as one of the obstacles to its realization.

Increases in the value of mature timber held for speculation are due only to economic factors. If this increase is reflected in taxation, as lawfully it should be, taxes pyramid just as on immature timber and may have the same consequences for the owner. Accurate valuation is less difficult because mature timber has a better established sale value.

The important thing to grasp in regard to recreational forests is that the land plus forest growth has a real estate value not based on the present or ultimate conversion value of the timber. To be sure, generally speaking, the larger the trees, the more desirable the forest for recreation; hence the more it is taxed. Removal of the forest will reduce the recreational value perhaps more than the worth of the crop, but, if the land is so situated as to have a real estate value anyway, the taxes will not decline to the very low level of ordinary "cutovers."

To sum up: If forests, whether immature, mature, or used for recreational purposes, are taxed as legally they should be under the property tax, an owner who is holding them for future returns must pay pyramiding taxes on an investment from which he receives either no current income or only a minor one. This is always a theoretical and frequently a practical barrier to long-term forest investments of all sorts—even though it has been used as an alibi by many who would not invest in forestry under any circumstances. In the long run the present method of forest taxation also operates to the disadvantage of forest communities both by encouraging liquidation and by discouraging the building up of new forests.

Nevertheless, a tax may be bad in theory but, because it is applied at low rates and valuation, may do little actual harm. Probably a tax on babies would be a bad tax, but if each infant was valued at $1.00 and a $0.01 tax levied when it was born, the birth rate would not be changed. Under the next heading we shall therefore examine the actual workings of the property tax on forests under different conditions to see how far the tax barrier is practical as well as theoretical.

B. The Property Tax in Operation. The actual effect of the property tax varies with the tax needs of the community, the value of the forest, both absolutely and in relation to other property, the nature

and objectives of forest ownership, and the attitude of local tax officials. Sweeping statements for the country at large are untrustworthy. If there is a large tax base of agricultural or other "improved" property, the forest may get off lightly or the expense of government may be so high that all property is heavily taxed. Where the forest is the chief resource, the tax may fall heavily or lightly according to community needs.

If the assessors think that young forests are appreciating in value, they will put up taxes even beyond requirements of the law. If they do not realize that they have any potential value, taxes may not be increased until the new stand is merchantable. The best approach is to divide forest lands into three general classes—(1) denuded; (2) containing mature timber which is actually or potentially merchantable; (3) second growth—and to discuss each in the light of other conditions.

CASE 1. CUTOVER LANDS NOT RESTOCKING. Large-scale forest liquidation, not followed by reproduction, leaves the communities concerned in desperate financial condition (Chapt. XII, Sec. 12). Local officials struggle to find a valuation low enough to induce the owners to pay any taxes on the denuded land. Much land is abandoned anyway. Private reforestation of such lands is a doubtful venture at best (Chapt. VI, Sec. 11, and Chapt. XV, Sec. 6, Case 5). Under the property tax as legally it should be applied, it becomes a gamble. The hard-pressed communities certainly would raise the taxes as fast as the plantations grew, but tax reduction even to a practical zero affords no assurance that owners will take the other risks involved. Even a low and fixed tax amounts to a lot of money in fifty years (Chapt. XIII, Sec. 5). The denuded-land problem appears to be outside the realm of ordinary reform measures dealing with forest taxes (Sec. 8).

CASE 2. MATURE TIMBERLAND. Much timberland was purchased in the Pacific Northwest on a speculative basis, in which the carrying charges in taxes had not been correctly anticipated and the expected rise in prices has not occurred (Chapt. XI, Secs. 3 and 4). Local assessors naturally hesitate to reduce taxes in the face of rising needs of their communities, particularly as such lands are usually "outside owned" and represent the bulk of the taxable property and as many such areas may still be carried on tax rolls at inflated valuation. There is much talk of premature liquidation of such property because of the tax load. How far this is the only factor involved it is difficult to say. Other carrying charges may be a more important factor. Certainly valuation should be revised downward if present prices jus-

tify. Whether further tax relief than this is desirable is discussed in Section 7.

Tax reduction under liquidation is automatic. The valuation of each acre falls to that of the bare land, or drops enough to compensate for timber removed in partial cuttings. The natural reaction of the communities where liquidation is going on, where their tax base is replaced by valueless "cutovers," is to get while the getting is good and to increase the valuation of the remaining timber as compensation. One may blame them for increasing taxes to a point where liquidation may be the owners' only solution, knowing, as thoughtful citizens do, that the policy eventually will bankrupt the community; but the question, "Who knows but that they would liquidate anyway?" is hard to counter in view of past happenings. Low taxes automatically will not prevent forest destruction. Favorable taxation only can lower one of the operating costs of forestry.

If Case 1 is characteristic of large areas in the Lake States and of localities elsewhere, and Case 2 of many parts of the West, Case 3 (second-growth forests) concerns mostly the East and South.

CASE 3. SECOND-GROWTH FORESTS. It is necessary to break down discussion into large second-growth regions, where there is little other land use, and into woodlot regions and recreational regions, with the understanding that they overlap somewhat.

Second-Growth Regions. There are large cutover areas in the less densely populated and largely non-agricultural regions where second growth is advanced well enough to have prospective value. The lands were reduced to a low valuation when first cut and were more or less forgotten as a taxable possibility. Sales are rare; often the only purchasers are public agencies acquiring public forests. Their methods have prevented much speculative rises in price (Chapt. XIII, Sec. 8). Taxes are affected by ownership. Those of an owner who does nothing with his land usually remain low, at least until it reaches the merchantable or near merchantable stage. If he attempts cultural or special protective measures, they may be increased. Where one owner or a group of owners controls the bulk of the land, they are often able more or less to determine their own taxes (Chapt. IX, Sec. 11). On the whole, progressive and dangerous tax increases are probably more a threat than an actuality, one which is more likely to prevent expenditure of improvement funds than land abandonment.

Woodlot Regions. Taxation in most farm regions is complicated by the abandonment of agricultural lands; cultivated fields revert to pasture, then to brushland, and finally become forest of a sort. Until this

shows signs of yielding at least a crop of firewood, its value is declining. So the burden of taxation is shifted to the remaining crop and to other types of producing property. This shift often is masked by the practice of assessing the farm as a whole; so the owner has little idea whether or not his old field stands and young timber are overtaxed. The question which agitates the community is whether or not all property is overtaxed. In those areas where the cropland is generally poor and local affairs are badly managed, it may well be. Where there is still much good cropland and the local public business is well conducted, taxes may be very low. In either case, the people who pay the taxes do not elect assessors to overvalue their property. Undervaluation and high rates are therefore common (Sec. 4). The nonresident owner, having no voice in local affairs, may find himself suffering from both a high rate and a high valuation.

Recreational Regions. An influx of "outside" owners into forest areas, which is characteristic of private recreational regions (Chapt. IX, Secs. 5*D* and 6*E*), develops a new scale of tax values. The total area involved may be small compared with other forest areas but deserves consideration because the lands lie close to markets and ownership at least is potentially favorable to forestry.

This invasion requires increased public expenditure for more and better roads, more expensive schools, and so on, and creates a market among purchasers, not concerned with the producing capacity of the lands, who will pay more for them than the "natives" think they are worth. They are taxed accordingly. The necessity for higher tax receipts later raises all valuations to private-estate standards. As to forests, generally speaking, the larger and better developed the timber, the higher it is taxed.

This discourages holding forest land for economic returns from timber and restricts ownership to those who can afford the luxury. The owner attempting forestry may find his taxes increased because, say the assessors, his property has been improved for summer-home use. There are favorably situated areas where landscape-improvement cuttings do create real estate values immediately. However, except in the most intensively developed recreational regions, there are thousands of acres not suited for estate property that should be taxed on a woodland basis. Their nearness to markets justifies a higher valuation than similar lands in more remote locations but does not justify the inflated valuations at which they may be held.

No mention has been made of taxation on protection forests of a form such that their growth can have no timber value. These lands

generally are taxed on a basis that gives no cause for complaint. It would be dangerous to raise taxes to high levels because it might induce the owners to abandon the land or fail to keep it in condition to fulfill its protective function.

6. TAX CALCULATIONS

In Chapter XIII, Section 5, taxes were assumed not to vary, but it is now evident that generally they will increase with the value of the property but that the increase probably will be irregular in time and amount, depending on the vagaries of assessment practices. By knowing the practices in a given locality it is possible to approximate the tax total when the crop matures. It is also possible to figure the total taxes on the basis of an assumed regular annual increase in taxation. The method of determining the total of each kind of increase is shown below.

A. Determination of Total Taxes When the Annual Tax Is Increased Irregularly. Assume a paper company notes that the assessors usually raise the valuation of cutover land in about 10 years when reproduction is well established, and about every fifth year thereafter. The per acre taxes run: to 10 years, \$0.05; 10 to 15 years, \$0.10; 15 to 20 years, \$0.12; 20 to 25 years, \$0.16; 25 to 30 years, \$0.21. Interest is at 4 percent. What will be the total tax on an acre held for 30 years?

The problem is to determine the sum of a series of overlapping annuities (Formula 6, Chapt. VI, Sec. 8*G*), running for different periods, the first being for 30 and the last for 5 years. The rent (*AR*) of each annuity after the first is the amount of tax increase over that in the preceding period. Expressed as a formula this becomes

$$V_n = \frac{AR1(1.0p^n - 1)}{0.0p} + \frac{AR2 - AR1(1.0p^{n-a} - 1)}{0.0p} + \frac{AR3 - AR2(1.0p^{n-b} - 1)}{0.0p} + \cdots$$

[*Formula 16—Sum of Irregular Tax Increases*]

$AR1$, $AR2$, $\cdots$ represent the annual tax during the different periods, and $n - a$, $n - b$, etc., the years in each annuity succeeding the initial one.

Solution of the above example is

$$V_n = 0.05\frac{(1.04^{30}-1)}{0.04} + 0.05\frac{(1.04^{20}-1)}{0.04} + 0.02\frac{(1.04^{15}-1)}{0.04}$$

$$+ 0.04\frac{(1.04^{10}-1)}{0.04} + 0.05\frac{(1.04^{5}-1)}{0.04}$$

$$= 0.05(56.0849) + 0.05(29.7781) + 0.02(20.0236)$$

$$+ 0.04(12.0061) + 0.05(5.4163)$$

$$= 2.80 + 1.49 + 0.40 + 0.48 + 0.27 = \$5.44$$

We can deduce from the above that a small increase in taxes early in the rotation may be more significant than a larger one later.

B. Determination of Total Taxes When Increase Is Annual and Regular in Amount. If one assumes a regular annual tax increase, it is convenient to assume that each year it will augment by the amount of the first payment. Such an increase is known as an *increasing arithmetical series.* Suppose taxes start at \$0.02 per acre and increase each year by \$0.02. With interest at 5 percent, what will they total in 40 years? The following formula enables solution:

$$V_n = a\left(\frac{1.0p^n - n(0.0p) - 1}{0.0p^2}\right)$$ [*Formula 17—Future Value of an Arithmetical Series*] [1]

a = the initial sum and the annual increase and $0.0p^2$ indicates $0.0p$ squared. Substituting,

$$V_n = 0.02\left(\frac{1.05^{40} - 40(0.05) - 1}{(0.05)^2}\right) = 0.02\left(\frac{7.0400 - 40(0.05) - 1}{(0.05)^2}\right)$$

$$= 0.02\frac{(7.0400 - 2 - 1)}{0.0025} = \frac{0.0808}{0.0025} = \$32.32$$

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[1] It is obvious that the taxes plus interest for each year may be determined individually simply by the use of ordinary compound interest, Formula 2 [$V_n = V_0(1.0p^n)$], V_0 and n having a different value for each year, and the total taxes then arrived at by addition. *Since taxes are paid at the end of the year, they bear interest for one year less than the length of the period, and those for the last year bear no interest.* Letting a equal the taxes for the first year, the taxes for the second year become $2a$ and, for the last year, na. From this we can construct an omnibus formula for total taxes plus interest:

$$V_n = a(1.0p^{n-1}) + 2a(1.0p^{n-2}) + 3a(1.0p^{n-3}) + \cdots na$$

Assume that taxes amount to \$3.00 the first year and increase by that amount

If taxes had remained at \$0.02 the accumulated total would have been only \$2.42 (Formula 6). Obviously such a tax progression, applied to forests, would require very high yields and selling prices to make the enterprise attractive.

C. Determination of Total Taxes When Annual Tax Is Reduced at Intervals. Tax reductions may occur during the life of a stand because of a decline in valuation due to a severe economic depression, a fire, or other calamity, or due to partial cuttings. These reductions, if they come, will be irregular in interval and amount. Calamities cannot be forecast, but expected partial cuttings can, and with knowledge of assessment values and practices the probable tax cost can be calculated.

Assume a 20-year stand which in 15 years will justify a medium pulpwood cutting; 10 years thereafter, another but heavier one. Five years later the remaining trees, having reseeded the area, can be removed. Valuation starts at \$20 per acre. After the first cutting it drops to \$18 and after the second to \$15. If the tax rate remains unchanged at 2 percent and the interest rate is 5 percent, what will be the per acre taxes if the operator buys when the stand is 20 years old and sells after the final cutting?

There are three different tax annuities to be figured. The first two stop before the end of the period, but the interest continues to accumulate on their individual sums to the end of Period 3.[1] The following tabulation should make this clear.

Period	*Annuity (Years)*	*Interest on Sum of Annuity (Years)*
1	15	15
2	10	5
3	5	0

annually for 4 years, with interest at 5 percent. What will be their total? Substituting,

$$\begin{aligned} V_n &= 3(1.05^3) + 6(1.05^2) + 9(1.05) + 12 \\ &= 3(1.1576) + 6(1.1025) + 9(1.0500) + 12 \\ &= 3.47 + 6.61 + 9.45 + 12 = \$31.535 \end{aligned}$$

The above omnibus formula becomes by algebraic manipulation Formula 17. For short periods calculation is about as simple by the omnibus method as by the consolidated formula. *Note:* In checking one method against the other it is necessary to remember that n would = 5 in the above example if Formula 17 were used and that an exact check between methods seldom can be obtained without using a table running to more than 4 places of decimals (Footnote 2, p. 84).

[1] This is on the accounting basis of carrying forward all costs to the final harvest, explained in Chapter XIV, Section 10.

The total taxes can be figured by combining Formula 6, Sum of an Annuity, and Formula 2, Compound Interest, thus: $V_n = AR[(1.0p^n - 1)/0.0p] \times (1.0p^n)$ for the first two periods, *it being understood that the n may have a different value in each of the formulae,* and using Formula 6 only for the final period.

A generalized formula for solving problems of tax reduction, good for any number of reductions at regular or irregular periods, is

$$V_n = AR1\,\frac{(1.0p^{n-a} - 1)}{0.0p}\,1.0p^a + AR2\,\frac{(1.0p^{a-b} - 1)}{0.0p}\,1.0p^b + \cdots ARX\,\frac{(1.0p^x - 1)}{0.0p}$$

[Formula 18—Sum of Taxes When Annual Tax is Lowered Irregularly]

$AR1$, $AR2$, $\cdots$ indicated annual tax in the different periods, starting with the first, n, the length of the rotation, a, b, etc., the time from progressive tax changes to the end of the rotation.

Substituting the figures given in the example above, the formula reads

$$V_n = 0.40\,\frac{(1.05^{15} - 1)}{0.05}\,1.05^{15} + 0.36\,\frac{(1.05^{10} - 1)}{0.05}\,1.05^5 + 0.30\,\frac{(1.05^5 - 1)}{0.05}$$

$$= 0.40(21.5786)2.0789 + 0.36(12.5779)1.2763 + 0.30(5.5256)$$

$$= 1794 + 5.78 + 1.66 = \$25.38$$

If the taxes had not been reduced, the total would have been \$26.58. Since under the schedule outlined above the higher tax remained in effect the longest period, the reduction was less than it would have been if cutting could have been started earlier.

Formulae 16 and 18 can be combined to provide for calculation of both increases and decreases in taxes, which would occur if they were increased in a stand early in its life and decreased later owing to partial cuttings.

D. Determination of Total Taxes When Reduction Is Annual and Equal in Amount. Taxes may be expected to decrease in approximately regular amounts when mature timber is liquidated. Assume an operation with a life of x years. If the area cutover annually is equal and there is no increase in taxes on the uncut timber, the valuation of the cutover area must drop to that of bare land. If it is sold

or allowed to revert to the community for non-payment of taxes, all taxation ceases the year of the last cuttings. Meanwhile taxes and interest continue on the uncut area but in progressively decreasing amounts. Mathematically this is described as a *decreasing arithmetical series,* the sum of which is determined by the formula

$$V_n = \frac{T}{n}\left(\frac{1.0p^n[n(0.0p) - 1] + 1}{0.0p^2}\right)$$ [*Formula 19—Sum of a Decreasing Arithmetical Series*][1]

T equals the initial payment and n the number of payments or years, and the expression $0.0p^2$ means $0.0p$ *squared.*

Assume a liquidation operation running for 16 years in which the taxes in the first year amount to \$800 plus interest at 6 percent. If the per acre taxes on the uncut area are not changed or the cutting schedule altered, and the land abandoned as it is cleared, what will be the total taxes? Substituting in Formula 17,

$$V_n = \frac{800}{16}\left(\frac{1.06^{16}[(16 \times 0.06) - 1] + 1}{0.06^2}\right)$$

$$= 50\left(\frac{2.5404[(0.96) - 1] + 1}{0.0036}\right)$$

$$= 50\left(\frac{2.5404(-0.04) + 1}{0.0036}\right) = 50\left(\frac{-0.101616 + 1}{0.0036}\right)$$

$$= 50\left(\frac{0.898384}{0.0036}\right) = \$12{,}477.58$$

If the owner had intended to hold the cutover lands, it would have been necessary to add the cost of taxes plus interest to this sum, using

[1] One can figure regular tax decreases by individual years, as was done for tax increases (Footnote 1, p. 339), the total then being ascertained by addition. Letting t, t^1, $\cdots$ t^n equal the cash payment each successive year, the omnibus formula is written

$$V_n = t(1.0p^{n-1}) + t^1(1.0p^{n-2}) + t^2(1.0p^{n-3}) + \cdots t^n$$

t^1 $\cdots$ being determined by dividing the taxes of the first year into the number of years and subtracting the result for the successive years. Thus, if the taxes for the first year are \$30 and the period is 3 years, the decrease is \$10 per year, $t^1 = 20$, $t^2 = 20$, and $t^3 = 10$. By algebraic manipulation this omnibus formula consolidates to Formula 19. Calculations of the above example at 6 percent are

$$V_n = 30(1.06^{3-1}) + 20(1.06^{3-2}) + 10(1.06^{3-3}) = 30(1.06^2) + 20(1.06) + 10$$
$$= 30(1.1236) + 20(1.06) + 10 = 33.71 + 21.20 + 10 = \$64.91$$

the annuity formula (6) to do so. By treating the annual cash saving in taxes, namely $50, as the first term in an increasing arithmetical series, and using Formula 17 for its solution, one may determine the saving in taxes gained by liquidation. The present value of the taxes can be determined in Formulae 17 and 19 by inserting the discount factor in the divisor, as was done in Formula 7, which discounts an annuity (Chapt. VI, Sec. 8*H*).

7. FOREST TAX REFORM

The theoretical, and at times practical, disadvantages of the property tax as applied to forests has resulted in many reform attempts. Nevertheless, the problem is far from solved. It involves complex questions of public policy and administration leading to the framing of specific legislation. Policy revolves around the question: Should forest owners be subsidized through tax reduction, as are private educational institutions, on the theory that forest products are also a public necessity, or should they merely be taxed so as not to discourage forestry?

Regardless of policy, there is a distinction between holding mature timber for a price rise and investing in growing forests, even if taxes pyramid on both. Investments in mature timber, like those in undeveloped real estate, are attempts to realize an unearned increment (Chapt. V, Sec. 3). No one suggests that taxes be reduced for the benefit of financially distressed investors in idle land on the outskirts of a city because these investors guessed wrong as to population increases. If it is in the public interest to prevent too rapid liquidation of mature timber, precautionary measures should be taken, but not necessarily by tax reduction. Timber raising is an investment requiring more than purchase price and taxes, and increase in value is not unearned increment. The investment cannot stand progressive taxation such as is legal under present laws. The public owes it to the owner and to itself not to tax property in a manner preventing its constructive use.

As to whether tax reduction on growing forests should be made on a subsidy or merely a justice basis, the following questions are in order: Would a subsidy based on tax abatement automatically result in the practice of forestry? If a subsidy is required, should it not be given under conditions of a contract—something difficult to do where tax reductions are involved? Finally, should a group of taxpayers be subsidized by raising taxes on their immediate neighbors, as would automatically result if forest taxes were lowered to a subsidy basis?

Before discussing special forest tax laws it is wise to consider the possibilities of improving the operating of the general property tax. Such improvement is needed on its own account and is perhaps prerequisite to sound forest taxation. The basic property tax laws are state creations, but assessment and collection are by local officials with little if any state supervision. In small communities one must not expect that assessors will have much grasp of complex problems of valuation and property classification. Often property is not inspected when assessed. The assessors have no adequate property maps; acreages are taken from old deeds known to be inaccurate. Property may go unlisted for years, and no one but the owner knows it. Collections are often as slack as assessments; so property that has paid no taxes for years may remain in the owner's possession.

This chaos in rural taxation goes back further than incompetent tax officials. It stems from the existence of small administrative units, which have outlived their usefulness. These counties, townships, and school districts, laid out when transportation was difficult and community problems simple, still function as in grandfather's time. Today they are too small to be capable of dealing with modern administrative problems. Wholesale consolidations would cheapen administration, increase efficiency, widen the tax base, and lower (or at least more equably distribute) the tax burden.

State action to effect such consolidations is likely to be blocked by the united opposition of all these small units, which automatically fly to each other's rescue if any one of them is endangered. Reform in this direction seems destined to be slow, but the present tendency to extend state administrative control over local taxation should be of some help.

It is difficult to pass comprehensive forest tax legislation and, once passed, the hostility of local assessors reduces its effectiveness. State constitutions or organic tax laws usually require property to be taxed at full valuation. The basis of objection to property tax on forests is just this provision; consequently either fundamental changes must be made or a way found around the difficulty. It is hard to make such changes, particularly if they involve passing new laws for special kinds of property. Such laws always look like favoritism and are opposed by those not concerned and by taxing units that fear their powers will be restricted or their potential revenues cut off. Most state forest tax laws are therefore compromises permitting owners an alternate scheme of taxation.[1]

[1] Copies of these state laws may be obtained from the United States Forest Service, Washington, D. C.

The following section considers the basic principles of forest tax legislation, and discusses actual and proposed laws.

8. FOREST TAX LAWS

The bases of a satisfactory forest tax system would seem to be (1) reasonably cheap and efficient local government (Sec. 7); (2) legal land classification, in which lands suited only to forests are segregated from other lands (Chapt. IX, Sec. 7, and Chapt. XIII, Sec. 5); (3) further classification of forest lands on the basis of their producing capacity; (4) separate valuation of land and timber (Chapt. XIII, Sec. 6); (5) forest lands taxed in a way both to provide local communities with current income and to permit deferment of enough taxation to make forestry economically feasible.

A workable forest tax law, applied either to growing forests or to mature ones held for exploitation, must therefore reconcile two fundamentally conflicting objectives. *It must permit the owner to pay taxes when he harvests his timber, and at the same time furnish the community an approximately even yearly flow of tax revenue large enough to be significant.* Manifestly, the first objective is attainable simply by abating property taxes while the crop is growing and by applying an income tax to it when it is harvested. Such an income tax is called a *yield tax.* It should not be confused either with present federal or state income taxes or with a timber severance tax. These taxes are imposed on top of property taxes and not as a substitute for them (Secs. 10 and 11).

However satisfactory a yield tax might be to forest owners, it would supply the community with an even flow of annual tax revenue only under the unlikely condition that timber of approximately the same value was cut annually. In other words, if forests in a taxing unit were on a sustained-yield basis. Even then the receipts would fluctuate undesirably with prices of forest products (Sec. 5*A*). From the owner's standpoint the advantage of paying his taxes when he sells his crop is incontestable. Nevertheless, some features of the yield tax may not be to his advantage. Since few owners keep cost accounts over long periods to make a net yield tax practicable, it must be a *gross tax,* which at high rates is dangerous (Sec. 2*B*). Since a yield rate must be fixed far in advance, one that looks low now may turn out later to be high enough to put the owner in the red or be so low as to be unfair to the community.

Despite these objections, it is difficult to escape the conclusion that some sort of deferred taxation, with final taxation on an income basis,

is essential to a solution of the forest tax dilemma. The way to defer is *to defer,* and forest tax literature and legislation are replete with schemes to defer. These schemes involve one or more of the following features: tax exemptions, tax-reducing yield taxes, state assumption of current taxation, the owner's paying some sort of a tax when the crop matures.

Full tax exemptions on private forests during their entire lifetime, so far as known, has not been allowed anywhere in America, but a number of states allow tax exemption on young forests, sometimes on a general scale, sometimes applied only to "listed" lands (p. 347). The exemption periods range from 10 to 40 years. Certain states exempt both land and forest growth; others restrict exemption to the forest growth only. The theory behind these laws seems to be that the tax saving in the early stages of the enterprise will be sufficient to induce owners to make plantations or encourage natural reproduction. California, Connecticut, Colorado, Delaware, Maine, North Carolina, Rhode Island, and Vermont have special or general laws of this type.

In order to prevent the pyramiding of taxes on growing forests, some states specify the rate of taxation or the valuation to be placed on forest lands. Others specify both so that the annual tax becomes fixed in amount. Still others do not go that far but limit assessments and rates to keep taxes low. Limitations of some kind on the powers of assessors to raise valuations and rates is doubtless a good thing, but the fixing of a specific tax neglects the possibility of changes in general levels of all taxation and of violent changes in the value of money (Chapt. VII, Sec. 3) that later may involve either the owner or the public in difficulties. The following states have some form of tax reduction or tax stabilization: Connecticut, Idaho, Indiana, Iowa, Louisiana, Ohio, Oregon, Michigan, Minnesota, Vermont, Washington, Wisconsin.

Only one state (New York) permits deferment of all taxes and the payment of a yield tax when the crop matures. Most states having yield taxes (which include most of those listed in the previous paragraph) tax the land under state-controlled methods such as discussed above, the intent being to keep the annual tax very low. Of the yield-tax states only Alabama exercises no such control. Certain states (Indiana and New Hampshire) have adopted deferred taxation on a different basis from the yield tax.

Two states (Kentucky and Virginia) have adopted laws under which the state leases the land and assumes all or part of the current taxes on land and timber. Under the Virginia law the owner pays all accrued taxes plus interest when the crop is harvested. In the Ken-

tucky scheme the owner and the state split the sale price of the timber 50–50 when it is cut, and the owner then pays the accrued taxes.

Nearly all these laws are optional with the owner. He must go to some trouble to list his lands [1] under them, sometimes entering into a contract with the state to manage his lands in specified ways.[2] Owners have not widely taken advantage of these laws.[3] The reasons vary from fear of tax reprisals on the owners' other property or from fear of excessive state control to satisfaction with existing taxation, inertia, or sheer lack of interest in forestry. In many cases the laws themselves are so hedged with restrictions to prevent their being unfairly used or are so complicated as to be unworkable. Only in Washington and Oregon may the state take the initiative in listing lands. Perhaps forest tax laws to be successful must be simpler, more inclusive, and obligatory on forest owners.

The special tax problems of protection forests and mature timber have received less attention than immature forests supposedly for timber production. Only Wisconsin and Hawaii have made special tax provisions for protection forests. Wisconsin exempts small areas of such forests attached to farms, under condition that the owner improve or maintain them in condition to perform their protective function. The Hawaii law is similar except that there are requirements as to area and the land need not be connected with a farm.

Recently the state of Washington decided it to be public policy to defer a portion of the taxes on mature timber to prevent its unduly rapid liquidation (p. 343).[4] The law declares the land to remain real property but treats the timber theron as personal property and taxes each on a separate basis. The land is taxed at 50 percent of full valuation and is valued on the assumption that no timber stands upon it.

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[1] These listed lands are often called *auxiliary state forests.*

[2] Some authorities question whether such agreements are binding on the states, or can legally be made so. See Fairchild, *Forest Taxation.*

[3] According to figures of the United States Forest Service, dated October, 1939, the total area listed under these laws was 2,367,168 acres; the numbers of owners 6797, and the cumulative yield tax receipts $47,367. Oregon had the largest listed area (736,083 acres). Only 5 states listed more than 100,000 acres, and several less than 1000. Some states with listing laws had no listed land. These figures do not include states which allow exemptions for young forests but do not require listing. Doubtless, all these figures have increased, probably chiefly in Washington and Oregon, where the state takes the initiative in listing, but compared with the vast areas of immature forest in the United States they are still insignificant.

[4] The law is unrelated to other forest taxation laws of the state mentioned earlier.

The timber is taxed annually on a diminishing scale for 10 years; thereafter, on a fixed basis. Part of the tax is paid annually, the rest is deferred until the timber is cut, when the deferred tax plus interest becomes due. The state takes the initiative in land classification, but the owner has the right to appeal in favor of the present annual tax system. The rather complicated provisions of the new law may lead owners not burdened with present taxes to prefer conditions as they are.

A few years ago the United States Forest Service made an elaborate study of forest taxation in the United States, headed by Professor Fred R. Fairchild.[1] At its conclusion he and his associates proposed three schemes for solving the forest taxation dilemma without running into the objections of other plans adopted in the past. All are supposed to be obligatory and to give relief to both growing and mature forests. For their successful operation, all would apparently require either complete state administration or a much more definite state control over local assessment than is now common. None have as yet been adopted, although features of some of them are found in a few of the existing laws. These methods are called by their authors the "differential timber tax," the "deferred timber tax," and the "adjusted timber tax." Description follows.

The *differential tax* is simple in principle and operation. In essence it consists in a property tax on the land and reduced taxation on the timber, the latter obtained by reducing its assessed value by a fixed percentage. The scheme is in this respect the same as that used in some of the states that levy taxes on a fixed percentage of valuation. No provision is made for an income tax on the final yield, but the timber tax collected under reduced assessment is supposed to approximate what would be paid under a yield tax when the crop is harvested. The reduction factor is supposed to be from 5 to 50 percent, depending on many considerations, and to be uniform for the state at large or for definite forest regions within it. It is estimated that this will afford sufficient tax relief to owners without crippling the communities. Only trials after careful studies of the probable effect on both would determine this. The possible necessity of using quite different reduction factors even in the same locality might destroy the essential simplicity of the plan.

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[1] Fairchild and Associates, *Forest Taxation in the United States*, United States Department of Agriculture, Miscellaneous Publication 218, Washington, D. C., 1935.

The *deferred timber tax* employs the yield tax as applied to timber, leaving the land tax under the property tax. The owner pays the land tax annually and a yield tax equivalent to the accrued property tax on the timber without interest when he cuts. However, he pays this yield tax to the state instead of to the local taxing unit. The state pays the annual property tax on the timber to the local tax unit, reimbursing itself later from the deferred-tax payments. Under this plan the owner escapes interest charges on his timber taxes but not on his land taxes. On the other hand, if he never cuts his timber he escapes taxation on what may be the chief element of value in his property.[1] The communities always get their regular tax receipts. Since the state acts as banker, extending credit to the owner and cash to the community, it must set up a rotating fund to operate the plan.

To protect both itself and the owner, the state probably would need to take a definite part in local assessment to prevent land values' being pushed up unduly by local assessors and also would need to watch the owner to see that the crop tax is paid. For its services as banker, administrator, and policeman, the state might be justified in retaining a small percentage of the timber tax.

The *adjusted property tax* is a complicated device intended to reduce the current property tax on a deferred-yield forest by an amount proportioned to the extent of income deferment in each individual case. It is well described by Hall.[2]

> The adjusted property-tax plan is based on the fact that if a deferred-yield property is relieved from that part of the property tax which is levied upon the increase in value that is expected to come with the payment of taxes and the accumulation of interest in advance of receipt of income, it will bear a tax burden approximately equal to that which it would have borne under an income or net-yield tax (were such a tax practicable) at a rate equivalent to the property-tax rate. Accordingly it requires that the current tax base of a deferred-yield forest be adjusted by deducting from the current assessed value of the forest the amount of interest and taxes accumulated to the end of the preceding year. As income is realized, this deduction would be gradually eliminated. Thus the deduction in any given year (termed the "adjusted value increment") would be equal to: (1) The adjusted value increment accumulated to the beginning of the preceding year, plus (2) the adjusted value increment of the preceding year, composed of (*a*) the pure interest

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[1] A maturity period could be specified in such a law if adopted. This is common in most yield tax laws now on the statute books.

[2] R. C. Hall, *The Forest-Tax Problem and Its Solution,* United States Department of Agriculture, Circular 358, Washington, D. C., 1935.

(approximately the rate paid on long-term, tax-free Government bonds) on the assessed value of the preceding year, plus (*b*) taxes paid during the preceding year, minus (*c*) gross income or yield (from stumpage, etc.) received during the preceding year. When the income exceeds the sum of the other items no deduction is required. The tax on this reduced tax base is to be paid at the same rate as that applied to other real estate in the taxing district.

The practical effect of this scheme would seem to be to equalize approximately tax payments throughout the rotation, payments being higher in its early years and lower in the later ones than under an unmodified property tax if applied as it legally should be. The adjusted tax has the advantage, therefore, of making taxes a somewhat known quantity and of preventing tax pyramiding and provides a reasonably stable revenue for the community. But it is difficult to understand and requires a lot of bookkeeping. Perhaps these considerations outweigh its other advantages.

Continued experimentation with forest taxation is to be desired and expected. Some of the plans now in operation may fail; others, succeed. Some or all of those proposed may be tried out. Still other schemes will doubtless be advocated or tried. Out of all these trials and probable errors, it is to be hoped that more rational forest taxation will result. It is not likely, however, that all 48 states will solve the problem in the same way. It should be remembered that forest tax reform can only encourage forestry, not initiate it. If forestry does come into existence, with or without general tax reform, and if the bulk of the forests in a given community are operated on a sustained-yield basis, most of the special difficulties of forest taxation under the property tax will disappear.

9. TAXATION ON PUBLIC FORESTS

The assumption that public land is always tax free is incorrect. Sometimes it is taxed, at other times payments equivalent to taxes are made. If two communities are of the same rank, one may tax the other, as when a city owns land for watershed or park purposes in surrounding communities. Exceptions occur by mutual agreements, or state law.

Local communities may not tax either a state or the federal government, for they cannot exercise sovereign powers over the governments which created or which control them. National and state forests, therefore, deprive a community of a portion of its tax receipts and, consequently, are often locally opposed. The national and state

governments, therefore, usually find it expedient to make some return to the local public treasury as compensation. Thus, in practice if not in theory, public forests may be taxed. Both states and nation naturally pay under conditions and in amounts largely of their own choosing. Sometimes when the areas involved are small they do not pay at all.

Various methods are used. One is for the state to value the lands or to decide the valuation method to be used and to pay on that basis (New York, Massachusetts, Connecticut, and Vermont). Another is to pay a fixed sum per acre, usually only a few cents (Pennsylvania, New Jersey, Michigan, Wisconsin, and Minnesota). In a third method the state may release the local units from all or a portion of their state taxes (New Hampshire) Most of the southern and western states assign a certain portion of the gross or net receipts of the forests to the local communities. Whatever the system, the state may or may not specify the use to which the payments shall be put.[1]

The national government makes distribution of 25 percent of the receipts of each national forest to the state in which it lies, with the proviso that the state distribute the monies so received to the counties in which the forest is situated in proportion to the national forest acreage located therein. They are to be spent for roads and schools in such proportions and under such conditions as the states may determine.[2]

The relative merits of these methods is a question of which best meets the needs of given situations. The distribution of a fixed portion of the receipts to the local community is logical in theory, but many forests can furnish little immediate income; so the community is not much benefited. On the other hand, overcutting might result from local pressure. A forest in full production might provide more than its proper share of the local public revenues. In no case will a percentage of the receipts bear any fixed relation to the tax needs of the community and, like an income tax (which in effect it is), will vary widely from year to year.

Payments based on the property tax principle should yield the local communities a more stable revenue and, so long as the state is the major factor in setting the valuation, it is not likely to result in over-

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[1] Copies or digests of the forest laws of the various states usually may be obtained from the United States Forest Service, Washington, D. C.

[2] For a copy of this law see United States Forest Service, *The Principal Laws Relating . . . to the National Forests,* United States Department of Agriculture, Miscellaneous Publication 135, Washington, D. C., 1939.

valuation and hence be unduly liberal to the communities. In setting the tax rate, communities have to keep private property in mind and therefore cannot secure inequable return from the state by raising it to offset a low valuation. The state, of course, can keep valuation too low and starve the communities. The New York law which freezes valuation on the public forests, called reforestation areas, at the initial assessment value or purchase price eventually may result in such a situation. A fixed sum per acre, set by law, is open to the same objection for public as for private land (Sec. 8).

As time goes on and conditions change and experience accumulates, many alterations will be made in all these methods. These changes will be tied in with possibilities of administrative reorganization of small tax units (Sec. 8) and the enlargement of public forests (Chapt. XX, Sec. 8).

10. INCOME TAXES ON FORESTS

This section is concerned only with the operation of the federal income tax[1] as it applies to forests. This tax is on net income and is related to gross-yield taxes, discussed in Section 8, only in that it is paid when timber is cut. It does not relieve the owner of any current property or other taxes.

In net income taxation much depends on the legal definition of the term "net." In one sense, the net income of a forest enterprise is its receipts less its expenses of operation. However, the timber which it has converted and sold was part of its capital assets. If, therefore, the company is taxed on its total income above operating expenses, it is paying taxes on a portion of its capital which it has used during the year and which presumably it does not consider profit but puts into a depletion reserve to buy or grow more timber (Chapt. VII, Sec. 4). The federal government does not consider that net income includes such temporary withdrawal of capital; so it is not taxable.[2]

The amount of tax reduction which may be obtained for depletion depends upon the valuation and depreciation method authorized. Valuation is on the basis of purchase cost with increases for deductions in amount as required.[3] Depletion, if figured on the basis of

[1] Not all states have income taxes, and in those which do the taxes are generally similar but lower in rate than the federal tax. Their methods of handling forest income is substantially the same as under the federal law.

[2] This applies also to other natural resources as coal, oil, and minerals.

[3] Valuation on the basis of current stumpage prices frequently would give quite different depletion allowances and often ones not related directly to actual capital recovery (Chapt. VII, Sec. 4).

size of cut and the average value per unit of the stand as a whole (as was originally done when the law was adopted),[1] equals or approximates the straight-line method—assuming equal annual cuts (Chapt. VII, Sec. 4). In clear-cutting operations where the timber is more or less uniform over the whole area to be logged, this is fair enough. In selection cutting where the larger trees or better or more accessible timber is first removed, depletion is much more rapid and the allowance by the above method insufficient. More recent rulings of the Bureau of Internal Revenue permit, if the owner desires, the depletion allowance to be figured on the basis of actual value removed.[2] This modification is of considerable assistance to owners working toward a second cut or sustained yield, or even in certain types of liquidation. The income tax also permits depreciation allowances from gross income for capital investment in equipment, mills, and logging roads.

Under income tax rulings, costs of certain forestry operations, such as establishing a new stand, are treated as current expenses and therefore are deductible from gross income; whereas, if they were treated on an investment basis, they would be regarded as coming from net income and hence be taxable. Actually expenditures of this kind may be either costs of operations or investments, depending on the intention of the owner and the system of accounting employed. Under a sustained-yield program, they are best regarded as current expenses (Chapt. XV, Sec. 6); otherwise they have the character of investments.

From the above it may be deduced that the federal income tax in principle takes into consideration the peculiar nature of forest property. If it is burdensome on the enterprise, it is because of its rates rather than its principles. When for any reason an enterprise has no net income, it pays no income tax, as was true in many forest enterprises during the late depression.

11. SEVERANCE AND INHERITANCE TAXES

These taxes were defined in Sections 3*C* and *D*.

A. Severance Taxes. The following states have severance taxes on forest products: Louisiana, Mississippi,[3] Arkansas, West Virginia,[3] and New Mexico. Those in Louisiana and Arkansas are specific, so many

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[1] Sections 19–23(m)20–28, Regulation 103, United States Bureau of Internal Revenue.

[2] E. T. F. Wohlengburg, "Forest Depletion: Federal Tax Allowance for Selective Logging," *Journal of Forestry*, Vol. 38, No. 2, p. 113, February, 1940.

[3] Called in these states a "privilege tax."

cents per thousand feet log scale, cord, etc.; those in the other states are ad valorem. The rates range from one-eighth of 1 percent in New Mexico to 3 percent in Mississippi of the value of material when cut. Since these taxes, whether specific or ad valorem, are assessed on the cut of timber without regard to any profit by the owner from its sale, they are in the nature of gross income taxes and do not exempt the owner from any other taxes. At very high rates they might be burdensome (Sec. 2*B*).

From the owner's point of view, a severance tax is just one more tax which, taken with his other taxes and the general prosperity of his business, may or may not be important. One must know the other taxes before discussing the specific effect of the severance tax. In any case it has the merit of not being due until the timber is cut, and therefore it cannot pile up interest charges. From a public point of view the effect of severance taxes on forests depends, as do all forest taxes, on whether they are for the benefit of the forest. Although some of the severance tax states distribute a portion of the tax to local communities, only Arkansas specifically allots its revenues to a "state forestry fund" for the "development of the forests of the state." Considering the theory of severance taxes (Sec. 2*C*), their proceeds can well be expended to perpetuate or prolong the life of the resources from which they are derived.

If the yield tax or other deferred tax were generally employed for forest taxation, a severance tax would become a part of it. A yield tax must be higher than a severance tax, for it is an overall instead of an additional tax.

B. Inheritance Taxes. This term is used here to cover any taxes paid by one who inherits property or by an estate being distributed. Such taxes [1] resemble property taxes, taking a proportion of the value of the property without reference to income. In large estates and bequests, the tax may be high; and in small ones, inconsequential or non-existent.

The effect of such taxes depends both on their amounts and on the nature of the property. If it is income-producing and the tax small, it may be paid from income. If the estate consists wholly or largely of non-income-producing property and the tax is large, it must be paid from capital.

For this reason inheritance taxes may be of importance to forestry. Assume an estate consisting largely of immature forest, or one pro-

[1] Both the federal government and many of the states collect inheritance taxes; they are in addition to ordinary court fees required in settling an estate.

ducing a yield, not commensurate with its future value. It may be necessary to sell it for what it will bring or to make heavy liquidation cuttings in order to get sufficient cash to pay the tax, thus sacrificing future income for the beneficiaries or disrupting a going business.

Inheritance taxes, of course, do not touch corporations which presumably live forever, but a business, organized in corporate form, owned largely by a single individual, may on his death also be affected in the same ways. So the incorporation of family forests, unless stock ownership is sufficiently widely dispersed, is not necessarily a protection to the property. Property placed in trust must also pay inheritance taxes (Chapt. III, Sec. 2, and Chapt. XIX, Sec. 4). Sometimes the courts will permit an estate to remain "open" long enough to realize on assets from future income without sacrificing assets—if the period necessary is not too long.

A desirable reform of inheritance and estate tax laws would be one giving the executor or heirs a period of years sufficient to pay death taxes without liquidating immature timber or breaking up a producing forest property, which if held together would be able in a reasonable course of time to meet the taxes from income as is done in Great Britain.

12. FORESTS AND TARIFFS

American forest products tariffs date from early days. During most of the time duties have been levied on some or all imports and they have been charged against our exports by some other countries. Since colonial times our exports have been a minor factor in our total production (Chapt. XI, Sec. 2), and foreign import tariffs have affected us but little. Our overseas imports, confined to special and luxury products, have been unimportant except to those immediately concerned. American import tariffs have been aimed chiefly at Canada—the only country from which large-scale imports have been economically possible.

The history of forest products tariff relations between Canada and the United States, projected against the obvious fact that the region on both sides of the boundary has a physical unity suited to promote a common economic life, is tedious and unedifying. It includes tariffs for revenue only, high protective tariffs, tariff wars, and periods of free trade.[1] Its economic key is the more rapid increase in population

[1] See R. C. Bryant, *Lumber,* 2d edition, John Wiley and Sons, New York, 1938; also A. R. M. Lower, *The North American Assault on Canadian Forests,* The Ryerson Press, Toronto, Canada, 1938.

and industrialization of the United States, which early turned it into a forest-product-consuming region, able to purchase in quantities from its northern neighbor, but not generally dependent upon it. Canada, being less industrialized and with a smaller population, has been compelled to sell the bulk of her forest products in foreign or overseas markets.

The tariff struggle has revolved around three poles: the Americans' wish to obtain or exclude Canadian products when and under conditions thought advantageous; the Canadians' desire to sell their products in their logical market; and the British Empire's changing policies regarding the economic relations between the homelands and the colonies. In this struggle, Washington has usually been in the strongest position, since it represents the biggest market, but Canada has had important cards to play because her provinces, having retained title to most of the forest lands, have controls over production in a way not possible for Washington. London's acts have concerned Canada chiefly. Before 1840 and since 1932 when she has wished to promote trade with her colonies, Canadian industry has gained. When the homeland thought its interest best served by free trade, Canadian lumber was at a disadvantage in the "home market" as compared with that from Scandinavia and the Baltic. These policies, except immediately after the American Revolution when British trade laws killed the American export business to the West Indies and threw the trade to the Canadian maritime provinces, have been of little consequence to the United States other than by occasionally making it harder for Americans to sell in British markets.

Despite Canada's desire to sell the maximum of forest products to the States, she has wanted an added profit from their home manufacture. Hence she has frequently set up export tariffs and embargoes on logs and pulpwood. The Americans have wished to use Canadian supplies as a supplementary source, admitting them free when needed and taxing them at other times, and always have tried to break down export tariffs and embargoes so as to profit from manufacturing the raw materials. When enough American lumber and pulp people wanted free trade they got it; when they wanted various degrees of "protection," they got them. Consequently, periods of free trade, low and high tariffs, have followed each other without consistent pattern except, as might be expected, that free-trade periods have generally come when American manufacturers near the line were exhausting their supplies and more distant American sources were not yet opened up. When the Canadians were in a strong position, they made their

export duties and embargoes stick; at other times, they had to modify them.[1]

Whatever the local effect of these changes, little indicates that they made much difference in price to the ultimate consumer or to the prosperity of the lumber and other forest industries as a whole; the American demand was too big, the Canadian supply too large, and the distance from its frontier to the more distant American consuming regions too great. The maximum imports in any one year have amounted to 2 billion ft. b.m. (1923), or about 5.4 percent of domestic production in that year.

Perhaps the late Professor Bryant has summarized the results to the American industry as well as anyone can. He says: [2]

> Lumber tariff legislation based on expediency as has been the usual practice in the past, rather than on sound economics, will not further the interests either of the lumber industry or the public, because it will neither keep foreign lumber from our shores nor provide an appreciable amount of public revenue. The cure for the present ills of our forest product industries will not be found in governmental control of international trade by tariffs and excises, but rather in the establishment of a rational relationship between domestic lumber production capacity and demands for lumber products.

What effect, if any, has all this had on the forests themselves? Both the advocates of tariffs and of free trade have stated their arguments in terms of forest welfare. Free traders hold that forest products should be on the free list because by encouraging imports they help conserve the home country's forest at the expense of those of other countries. Protectionists say that a heavy duty on imports of forest products will encourage forest owners to practice forestry since they will not need to fear foreign competition in the domestic market.

Such generalized arguments mean little. A tariff, import or export, designed solely to favor industry, is an added cost of production which, if it cannot be passed to the ultimate consumer, injures business. An import tariff so high that foreign lumber could not enter a country might have various results: raise domestic prices to the point of reducing consumption to the public disadvantage in one place; encourage domestic producers to liquidate as fast as possible in another;

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[1] The present war seems to be drawing Canada and the United States closer together in an economic sense. Perhaps both peoples may look forward to a time when their economic life will be more closely knit and hence more to their mutual advantage.

[2] *Op. cit.*

cause foreign retaliation to the disadvantage of the country's internal economy in a third. If it encouraged forestry it would be fortuitous, resulting at best in involuntary forestry (Chapt. X, Sec. 7). Heavy export duties might mean loss of trade to the point where forestry or even liquidation would be impossible. It is impossible to ascribe any clear-cut effect, good or bad, on the Canadian-American forest belt, traceable to the various tariff vicissitudes. Lower[1] seems to think that the forests of Ontario were more heavily overcut during the reciprocity period just previous to and during the American Civil War than when an American import duty was in force but admits that, considering the temper of the times, the forests would have been destroyed anyway. It does not appear that those of the Lake States were devastated less rapidly because Canadian lumber came in free at certain periods.

13. FOREST INSURANCE

In business occasional loss from fire, flood, or hurricane is to be expected. The very nature of these "acts of God" makes them unpredictable in time, place, and amount, but, after sufficient experience, it is possible to estimate the approximate danger from different destructive agencies to different types of property. Insurance then becomes possible. Suppose that a mill owner, after suffering flood damage two years out of six, decides that he must make expensive repairs every third year and sets aside an annual sum to cover them. He then has insured himself against flood damage. Individuals and businesses sometimes do self-insure themselves in this way, but most insurance is "written" by associations of property holders who, by sharing their risks, reduce each other's burdens or by corporations whose business is selling insurance. The associations are called *mutual* insurance companies; the corporations, *stock* insurance companies.[2]

Insurance other than life insurance may be considered one of the overhead costs of business. It can be obtained for nearly all kinds of property and against most forms of loss. Exception must be made for forests. It is practically impossible to insure the chief asset of the forest industries.[3] This introduces unusual business hazards into both the production and manufacture of forest products. They find their

[1] *Op. cit.*

[2] There are other forms of insurance organizations, but they are not important here.

[3] Insurance is written on conversion facilities in the forest industries just as it is in other businesses.

ultimate expressions in a restriction of flow of capital into the industries, in the expectation of higher rewards to capital for assuming the added risk, and finally in increased prices to consumers.

Forest insurance may be written in the future, but to understand the difficulties that must first be overcome it is necessary to consider something both of insurance problems in general and of those peculiar to forest insurance, giving most of our attention to the greatest hazard—fire. Insurance payments, like property taxes, are a percentage of the value of the property, paid annually or at other intervals. This is called the insurance rate and usually is expressed in cents per $100 or $1000 of value. Insurance may be taken out on full or partial value at the owner's option. In case of a fire the company agrees to pay only for the destruction actually done, at replacement cost (Chapt. VIII, Sec. 1*B*) less depreciation, and not more than the face value of the policy.[1] Assume that a house is insured at a cost value of $10,000, but, by the time of a fire which destroyed half of it, building costs had dropped so that it could be rebuilt for $9000; the owner would receive $4500. If the building had depreciated for lack of care by $1000, he would receive only $4000, even though he had been offered $12,000 for it the day before the fire.

Insurance rates are proportioned to the estimated possibility of loss, that is, hazard. The greater the hazard, the higher becomes the rate until finally it is so high that either the insurance company will not accept the risk or the owner cannot afford the premium.[2] Hazards may be classified as physical and moral. The physical ones have to do with the nature and surroundings of the property; the moral, with the character of ownership and to some extent of use. A fireproof structure, if owned by a prosperous company and located in a city with good fire, water, and police service, has a low physical and moral hazard. A tumble-down wooden building, outside a fire district, owned by a man gravely in debt, and used for a tough beer joint, is high both in physical and moral hazard. To use insurance parlance, one is a good risk, the other a poor risk. Rate structures are arranged in categories dependent upon the kind of construction and the degree of fire protection. The rates only indirectly reflect the moral hazard, which does not lend itself to satisfactory statistical treatment.

Each insurance company, unless dealing in special lines, tries to distribute its risks between different classes of property. An occasional fire, destroying a valuable building that is classed as a good

[1] Insurance term for contract.

[2] Insurance term for property owners' payment to company.

risk, may cost the company more than a number of fires in small poor-risk structures where, if there are no fires, the higher rate gives a higher profit. Companies also try to space risks geographically to avoid a general conflagration hazard. In spite of modern fire protection, every so often a fire gets out of hand and destroys a few blocks or a whole town. This danger may be small for the country as a whole but may break even the greatest company if it has written all the insurance on the area wiped out. To cover themselves against this special hazard, companies add slightly to the normal risk rate, distribute risks among themselves, and use other special devices. In instances of extreme hazard they may refuse to insure at full value or even to accept insurance at all.

Formerly, abundant and low-priced stumpage, high fire hazards, and pioneer forest industries were sufficient arguments against forest fire insurance, which even in Europe was not written until 1900. American conditions have changed. Forest fire protection is general, although not universal; timber is no longer abundant; and the industries are growing up. Although forest fire insurance has been experimented with on a very limited scale in America,[1] no large insurance company has really interested itself in its possibilities, nor has any group of forest owners attempted it on a mutual basis. The general attitude of the companies seems to be that such insurance is not possible except at prohibitive rates. A few studies have been made by the United States Forest Service to explore the hazard rates and set up certain criteria for successful forest fire insurance, indicating that the prevailing opinion may not be correct.[2]

The following discussion is written chiefly from these studies,[3] which have considered (1) the kinds of damage, (2) the nature and degree of hazard involved, (3) the basis of valuation used for insurance purposes and for figuring losses, (4) the rate to be charged, and (5) the form of the policies to be written.

Forest fire damage consists of injury to timber, mature or immature, to reproduction, and to the soil. These losses are both immediate and ultimate. A fire, running through a merchantable timber stand, may kill 60 percent of the trees outright; perhaps another 30 percent

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[1] D. M. Matthews, *Management of American Forests*, p. 414. See References.

[2] Failure of private insurance interests to offer forest insurance at reasonable rates, or of mutual forest insurance to develop, may sometimes cause the government to make provision for such insurance. There are precedents for publicly operated insurance schemes.

[3] Shepard, Technical Bulletins 551 and 651, United States Department of Agriculture, Washington, D. C. See References.

later die from injuries; and the remainder live on so badly fire scarred as to be worthless. The younger a stand, the larger the percentage that will be killed outright or that will be seriously damaged. Loss to reproduction may be important or not, depending on the stage of the stand. The burning out of the soil in extreme cases may ruin it for future crops; in others, have no great effect. If the timber is merchantable, part of it may be salvaged. If it is immature, the part killed is a 100 percent loss. It seems probable that a long period of experiment will be required before insurance will be practicable against all these types of losses. Probably it will be written soonest on mature timber, later perhaps on young timber, and finally possibly against site damage.

The fire hazard depends upon a complex of natural and human factors. On the natural side these include type and age of the forest, ground cover, topography, climate, and season. On the human side, efficiency of organized protection, proximity to special hazards, as active logging operations, slash and recreation areas, camps, highways, and the general attitude of the community toward forests. The difficulties of valuation, as a basis both for insurance and for settlement of damage, are apparent and are further considered in Chapter XVIII, Section 8.

Out of these complexities some sort of a rate structure must evolve which will classify risks into standard categories as they are in other kinds of property. Any attempt to rate each forest by itself would be too complicated; nor would it do to set a blanket rate, which would have to be so high as to discourage owners who have a low hazard, resulting in insurance's being written only on the poorest risks—not good business to the insurance companies.

Probably insurance would not be successful from the point of view of those issuing it unless it was written stipulating a certain degree of organized fire protection, provided by the public, the owner, or by cooperation between owners. There is nothing out of the ordinary in this because rates in building insurance vary with the degree of protection afforded, being higher for all classes of risk in those communities having inefficient fire-fighting facilities. Clauses in policies would be necessary under which full or partial cancellation would take place if protection standards fell off or if extra-hazardous conditions suddenly arose, such as accumulation of slash on a neighboring property.[1] A sufficient period would have to be allowed before dam-

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[1] Enforcement of such clauses would probably require frequent inspections by representatives of the insurance companies. Such inspections would be no de-

age claims are paid in order to allow for an accurate damage valuation. This period should not be less than one growing season.

Another very special condition in forests must be reckoned with. The hazard ordinarily ranges from almost zero in winter or in the rainy season to a high point in the dry season. Insurance usually is written for a yearly term, with privilege of cancellation on a monthly basis. Owners would have to be prevented from taking out insurance with the expectation of canceling it in low-hazard periods.

The general conflagration hazard is present in forests as elsewhere. Perhaps fire losses in a region are ordinarily low because of a combination of favorable climatic conditions and an excellent protective system. Even then, excessive drought, high winds with or without human and organizational failures, may be followed by conflagrations that elude all control and burn over large areas. These conflagrations fall into two classes, the great catastrophe and the occasional fire that burns over several thousands of acres before it is controlled. The first comes at long periods; the second, every few years; they commonly account for most of the damage in a given region. In the light of known conditions and past conflagration records this hazard is to some extent measurable.

In any region where forest fire statistics have been kept it is also possible to measure both the normal and the two kinds of conflagration hazards in terms of a *burning ratio* which can be expressed as follows:

$$\frac{\text{Average area burned per annum}}{\text{Total forest area}} = \text{Burning ratio in percent}$$

Knowledge of these burning ratios is the beginning of the development of an insurance rate structure. Shepard[1] believes that a rate structure by region, forest types, age classes, and perhaps political divisions can be made up (as he has done for the Pacific Coast and the Northeast) which would be low enough to justify owners' writing insurance and high enough to be profitable for insurance companies. There are, however, regions and localities where the hazards are too high to justify economic return on a rate that owners could be expected to pay. The rates quoted by Shepard are about 50 cents per

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parture from accepted practice in high-hazard property, sawmills, for example, where they are common practice. If an inspector finds that fire-fighting equipment is not maintained or that rules against smoking are not enforced, the insurance is canceled.

[1] *Op. cit.*

$100 of valuation for the Pacific Coast and somewhat less for the Northeast. These are tentative rates only; if a sufficient volume of business were developed, he thinks they could be materially reduced.

As to other forms of forest insurance, probably enough records of past hurricanes could be brought together to enable a tentative hurricane rate by major regions. Damage from ordinary blow-downs by occasional severe storms probably would not justify insurance. If building insurance rates are any criteria, hurricane rates should be materially lower than fire rates.

Hazards for more or less periodic visitations of timber-killing bark beetles might also be statistically determined and rate structures built on them. Introduced insects, which run amuck in their new environment, like severe earthquakes in regions where they have never been known to occur, doubtless always will remain outside the practical range of insurance. Probably little attention will be given to hurricane and insect insurance until forest fire insurance becomes well established.

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CHAPTER XVIII

THE APPRAISAL OF FOREST VALUES

In business transactions dealing with forests it is necessary to determine their monetary value. The process of determining them is called a *forest appraisal.* Considering only values arising from timber products, they are the values pertaining to the forest growth, those pertaining to the land, and those pertaining to improvements on it which facilitate the protection, growth, and conversion of the timber.[1] The land and improvement values are expressed finally in the value of the timber itself. This combined value is known as *stumpage* value.

Forest appraisals are of two distinct sorts: (1) those to determine the value of the stumpage now merchantable which it is intended to cut immediately or in a relatively few years; it is not expected that the amount will change save as a result of cutting; (2) those made with the intention of determining how a forest may be exploited most profitably over a considerable period of years or on a sustained-yield basis, *in consideration of the fact that trees do grow.* For convenience, the first are referred to as *stumpage* appraisals and the second as *growth* or *management* appraisals, even though the latter are themselves forms of stumpage appraisals. The first class of appraisals is usually made simply to arrive at a price for the purpose of a transfer of ownership; the second, by owners wishing to determine how best to manage their forests.

A third kind of appraisal is made to determine the loss to a forest from fire or other forms of damage. They are called *damage* appraisals and may involve either stumpage or management appraisals, depending on how the owner of the damaged forest has been handling his property. When forest resources other than timber are damaged and have a monetary value to the owner, they must be included in a damage appraisal.

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[1] The valuation of forests for protection, recreation, or wildlife purposes is really a matter of appraising land plus forest growth for a specific use in which the conversion value of the timber plays little or no part. Such appraisals are really specialized forms of land valuation.

1. STUMPAGE VALUES[1]

The expression *stumpage value*[2] often is loosely used. Here the term is considered to mean the monetary value of standing timber, based on the expected selling prices of the primary products into which it is to be converted, in comparison with the estimated cost of such conversion. Otherwise stated, it is a wholesale price for standing trees. It may be expressed in units of volume, as cords or board feet; those of area, as acre, section, or lot. The price may or may not include that of the land upon which the timber stands, depending upon whether it is necessary or desirable to purchase it to obtain the timber. Stumpage value has nothing whatever to do with any value which the timber may have for protection, recreation, or wildlife purposes, except that if these other values are high enough they may force a purchaser to pay more than he would otherwise for the timber (Chapt. VIII, Sec. 1).

The general economic factors which determine stumpage value were set forth in Chapter X, Section 4. Briefly, they are fixed by the expected selling price of products into which the timber will be manufactured, less the expected cost of their production, plus the profit which the operator expects to make on them with an allowance for risks of loss involved. Expressed as a formula this reads

$$\text{Stumpage value} = \text{Selling price of products} - (\text{cost of production} + \text{profit} + \text{risk allowance})$$

Since stumpage value is based partly on the price of the products into which it is to be converted, it is bound to vary with the kind, quality, and price of those products. As to kind of product, Dunham[3] has shown that a high quality loblolly pine, 16 in. d.b.h. o.b., with a usable length of 60 ft., growing on the coastal plain of Georgia or South Carolina, had (January, 1939) the following stumpage values, depending upon the use to which it was put.

Dunham restricted his study to one-sized trees of a single species. He did not attempt to show variation in lumber value due to differ-

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[1] General Reference: H. B. Steer, *Stumpage Prices of Privately Owned Timber in the United States,* Technical Bulletin 626, pp. 1–17, 1938.

[2] While there is a distinction between the terms "value" and "price" (Chapt. VIII, Sec. 1), current usage disregards it, and the terms "stumpage value" and "stumpage price" are here considered synonymous.

[3] W. E. Dunham, unpublished talk before meeting of Southeastern Section, Society of American Foresters, Gainsville, Fla. Figures were confirmed in personal letter by Dunham to the author (Feb. 23, 1939).

ences in size or species. Variations due to these differences as well as those due to conversion cost were considered in Chapter X, Section 2. Price variations at different times and places were discussed in Chapter XII, Section 3.

Products	Stumpage Prices	
1 50-ft. pole, Class 3	$1.50	
5.5 cu. ft. pulpwood @ 75¢ [1]	.03	$1.53
1 saw log, 12.7″ × 16′—76 L. ft. @ $5.00 M.	$ .38	
1 cross tie 7″ × 9″ × 8′ 6″ @ 15¢	.15	
2 cross ties 6″ × 8″ × 7′ @ 10¢	.20	
12.9 cu. ft. pulpwood @ 75¢ [1]	.06	.79
3 cross ties, 7″ × 9″ × 8′ 6″ @ 15¢	$ .45	
2 cross ties, 6″ × 8″ × 7′ @ 10¢	.20	
12.9 cu. ft. pulpwood @ 75¢ [1]	.06	.71
1 saw log, 12.8″ × 16′—76 L. ft. @ $5.00 M.	$ .38	
42.2 cu. ft. pulpwood @ $1.00 [1]	.26	.64
68.45 cu. ft. pulpwood @ $1.00 [1]		.43

[1] Based on a 5-ft. cord; difference in prices is due to difference in quality between knotty top wood and clear wood lower down the trunk.

The profit expected varies with the needs of the operator, the current rate of interest, the amount of capital invested, and the length of time necessary to realize on the investment. The risk allowance is a sort of insurance to cover contingencies such as changes in value of product, cost of operations, possibilities of loss from fire. In general, the longer the operation is expected to be, the more important this item becomes. Stumpage which for any reason cannot be exploited at a profit is said to have a *negative* value (Sec. 3).

Since both selling prices and production costs of forest products are known more or less and to some extent standardized by localities, general ideas as to the value of different kinds of stumpage, based on past experience in its exploitation, are common property in all logging regions. These average stumpage prices frequently may serve as a guide to buyers and sellers but are accepted by those who understand them only as values that require adjustment for particular tracts and methods of operations and as values which are subject to change with those of operating costs and prices of finished products.

These stumpage prices, like other wholesale prices, are more stable than retail prices because they cannot follow, in the nature of things, the almost day-to-day changes of retail prices. Their slow upward or downward trend is a reflection of similar changes in retail prices. It cannot be too strongly emphasized that stumpage prices, referring both to the average ones discussed in the previous paragraph and to those based on appraisals of particular tracts, which we discuss exclusively in the following sections, are speculative prices based on general or specific ideas of what particular forest products will sell for at some future time, near or remote, in comparison with similar ideas of cost of their manufacture.[1]

From the viewpoint of the seller of stumpage, its value depends on several factors, independent of its amount and quality, the chief of which is its proximity to market. If it is in a roadless region, some one must build a road before it can be exploited. If a public road is built, the owner may expect to receive and the purchaser can afford to pay more. In fact, anything that decreases the cost of exploitation increases value for both buyer and seller.

From the point of view of the buyer, the cost of stumpage—whether he buys it with or without the land—includes such carrying charges as its ownership may entail until exploitation is completed. Their amount depends on the magnitude of his purchase, the length of the exploitation period, the conditions of the sales contracts (Sec. 2), and the systems he proposes to use in logging and milling.

Stumpage value adheres to immature as well as to mature timber, but the term as commonly used applies only to merchantable timber, which is all that is considered in the following section.

2. STUMPAGE SALES

Stumpage is bought and sold under the following forms of agreements: (1) Land and timber are sold jointly; (2) the purchaser buys all timber without buying the land and without any conditions as to time or method of removing the timber; (3) the seller disposes of all or part of the timber with stipulations as to time for removal, methods of operation, and so on, and retains the land.

A sale including land and timber is fair to both parties providing the price is fair to both. One involving only the timber, but without

[1] Frequent reference has been made to inflated stumpage prices paid in the past, resulting from overoptimism in regard to expected price increases; nevertheless, their long-term upward trend (Steer, *op. cit.*) is not to be overlooked.

stipulation as to time in which it is to be removed, ordinarily is completely against the interests of the landowner because it gives the purchaser the effective use of the property as long as he desires, leaving the landowner only the satisfaction, if any, of ownership and the duty of paying taxes. Such sales occasionally are made by owners who think that the timber is to be removed at once; later they learn the import of a bad bargain.

Any timber sale not involving the land, to be fair to the landowner, must specify in some detail the amount of timber sold, the conditions under which it is to be removed, the way in which the area is to be left, and the time in which the purchaser has to operate. Such an agreement is called a *timber sale contract,* and it also includes prices to be paid, methods of payment, stipulations as to taxes, penalties for non-compliance, and anything else to which both parties agree.

An owner, practicing forestry on the basis of stumpage sales, will need to protect himself with very carefully drawn contracts, including provision for inspection to see that provisions are complied with. The timber sale contracts of the largest forestry operator in the world, the United States Forest Service, are elaborate documents. Those made between farmers and sawmill men are sketchy and, in addition to the fact that the prices are often below "market value" (Chapt. X, Sec. 5), are drawn chiefly in the interest of the purchaser.

In a sale between private parties, where the timber-removal period is to exceed one year, some provision must be made as to who pays the taxes on the timber to be cut. Timber is taxable property independent of the land on which it stands even though, when the land and timber are owned jointly, taxes are usually assessed on their combined value (Chapt. XVII, Secs. 4 and 5). The moment of cutting, removal from the property, or payment, or some other period might be specified as the time when title to the timber passed to the purchaser, who then became responsible for taxes. Different states have different provisions regarding taxation of land and timber when the two are in different ownership, which should be consulted when timber sale contracts are drawn.

Methods of payment are as varied as those of sale. The purchaser may pay a lump sum for all the timber on the tract, payment to be made before or after cutting, or it may be on a basis of volume cut (on an average value independent of that for different species and grades), or one adjusted to their different values. In large sales it is customary to pay on the basis of volume cut, the material being scaled by one party or the other or by an impartial representative of both.

Payment is then made at fixed intervals.[1] Large contracts sometimes provide for a sliding scale, based on current prices of finished products, or for periodic revision of stumpage prices, designed to take into account price changes of finished products.

The stipulations of a timber sale contract affect the stumpage price, which the purchaser can afford to pay and the owner can expect to receive. If the contract gives the purchaser a free hand as to logging methods and removal time, does not require him to assume any taxes or to pay until the operation is complete, he can afford to pay more and the owner is entitled to expect more than under one which requires him to go to greater expense in logging to preserve young growth, dispose of slash, pay taxes, and assume carrying charges by paying in advance of cutting. The landowner who desires to practice forestry must insist on provisions as to cutting methods which will insure the accomplishment of his objectives, and he cannot expect to receive as high a price as if he sold without such stipulations. Presumably he will gain through keeping his property in a more productive condition.

3. STUMPAGE APPRAISALS

A. Foreword. Stumpage appraisals[2] may be made by a prospective buyer, desiring to know how much he can afford to pay for a tract of timber, or by a prospective seller, wishing to determine what he ought to get for his own timber; or an owner may appraise his own forest to ascertain the probable profit if he converts it himself. Appraisals often are made by foresters and other experts acting either for owners or buyers.

An appraisal involves (1) a cruise to determine the location, quality, and volume of the timber; (2) an estimate of its probable cost of conversion; (3) an investigation as to its probable selling price when converted; (4) a determination of the desired profit; (5) the fixing of a safety factor or risk margin; and (6) the application of the formula (p. 366).

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[1] Sales of this kind are often called *royalty sales.*

[2] The best reference to this subject is still the United States Forest Service *Instruction for Appraising Stumpage on the National Forests,* published in 1922 and long out of print. The procedure outlined has been modified only in detail by the Forest Service. Although these instructions cover only appraisals under the limited conditions of national forest sales, where stumpage is paid for as cut and the operator's investment is limited to that necessary for conversion facilities, the other principles involved are of universal application and liberal use of them is made in this discussion.

The appraisal may be simple if the sale is for a small amount of material to be converted immediately or very complicated if the amount is large and the conversion period long. Let us follow a small portable-mill operator who is looking over a woodlot to see what he can afford to pay a farmer for the merchantable timber on it. He estimates that he can get 20 M. ft. b.m. from it, which will cost him $3.00 per thousand to log. He knows a wholesaler who is willing to pay $6.00 per thousand for the lumber at the mill. He figures $2.00 per thousand will be a satisfactory profit, adds $0.50 for "risks," and offers the farmer $1.00 per thousand, leaving $0.50 for a trading point to add if necessary. After a little bargaining the timber changes hands; the whole process consumed half a day, and the only paper work that was done occurred on the back of an old envelope.

A transaction involving a billion feet board measure, to be logged over a 20-year period, requiring the building of a mill, construction of logging roads, and purchase of expensive equipment, has no more basic elements, but it does involve determination of investment costs, depreciation and carrying charges, salvage values, interest rates, and careful estimations of risks. All this requires the services of foresters, timber cruisers, logging and milling engineers, economists and accountants, who must work months, and whose services and expenses will cost their employer thousands of dollars to build up an anticipated cost picture of a proposed operation. When this is done, the employer can also use the back of an envelope to apply the stumpage value formula.

The best way to understand the process is to follow through the collection and use of the various data as done in the following subheadings.

B. The Timber Cruise. This is an estimation of the amount of stumpage present on the area. In its simplest form it consists simply in a lump-sum estimate. This may be satisfactory for small sales where the timber is fairly uniform in size, species, and quality and where the operator is able to allow himself a considerable margin of risk, but it is entirely inadequate for a large sale or when profit margins must be figured closely. It assumes that each unit of stumpage[1] has the same value—an assumption contrary to fact. Each unit varies in value with its size and quality and with the cost of converting it and the product into which it is to be converted (Sec. 3*C*). A cruise

[1] A unit of stumpage may be a tree or a stand of uniform character (see following paragraph).

adequate for a sound appraisal must be in such a form that it is possible to value each stumpage unit separately.

In practice this means that the cruise must (1) tally the individual trees in terms of species, size, and grade;[1] (2) divide the forest into units of area based on logging costs. These units are called *logging units* or *chances*. If the forest is a mixed one on topography where logging cost will be more or less the same throughout, the unit of stumpage will be the individual tree. If it consists of more or less uniform stands, growing on quite different kinds of topography, the unit will be the stand. In the mixed forest the value of the stumpage unit, that is, the tree, depends largely on its size and quality and on the nature of the final product; in the second forest, where there is little variation in the trees and the stumpage unit is the stand, value depends chiefly on exploitation cost, the individual trees being of approximately equal value.

Since forests are subject to infinite variation, frequently it is necessary to use both forms of stumpage unit, but one or the other is likely to be the more important. If it is the tree, valuation is based on diameter analysis. If it is the stand, the valuation is based on stand analysis (Chapt. XV, Sec. 7). In either classification the cruise not only must record the size, quality, etc., of trees, but also must produce maps showing the topography and the dispersal of the timber in relation to it. The timber maps may be in terms of species, types, age classes, or average stands per acre—whichever serves best the needs of the particular forest.

By using forest mensuration techniques the volume estimates and the maps may be made at the same time. Their cost varies with the detail considered necessary, which in turn varies with the apparent value of the tract. The more it appears to be worth, the larger the expenditure justified in determining its true value. The costs of the cruise (together with other appraisal costs) must figure eventually in the stumpage price itself (Chapt. XIII, Sec. 8*A*).

C. Production Costs. Having determined the amount and quality of the timber and the kind of products it yields, the next step is to determine what it will cost to put it on the market in terms both of raw materials and of finished products. In this calculation the job is broken down into the familiar categories of logging, delivery, milling, and selling costs. Each step involves direct costs of labor and ma-

[1] Since it is not always possible to determine grade in the field this may have to be done by results of mill studies of similar timber.

terials, overhead costs of supervision, taxes and similar items, and investment costs for mill, logging and transportation facilities.[1]

Before the logging and milling experts can start detailed work, certain decisions must be made as to the operation as a whole, chiefly as to how long it is to run. The length of the operation, that is, liquidation period, determines the rate of depreciation (Chapt. VII, Sec. 4) and the amount of equipment necessary (Sec. 3*D*). The liquidation period may be set by a desire to recover capital within a given time or by deciding that a mill of given capacity will require a certain number of years to convert the timber (Chapt. VIII, Sec. 2*C*, and Chapt. X, Sec. 5). Ideally it should be set so as to give the highest present value or the greatest return on invested capital (Chapt. XIV, Sec. 13). Whatever basis is used, various trial estimates probably will be made to determine the length of operation. It is also necessary to make such estimates in order to determine the mill location that will permit the cheapest total conversion cost of the timber (Chapt. X, Sec. 3).

These points having been decided, the logging engineer must make a logging plan, using the maps provided by the forester (Sec. 3*B*) as a basis, supplementing them with such detailed surveys for road locations and other logging improvements as may be necessary. He must determine the cost of construction of his improvements, the cost of the equipment needed for operations, and the operations and maintenance cost of its use. In so doing he draws in part on average costs of similar operations or equipment in the past, as ascertained from his own experience, from that of his associates as well as that published in forestry and trade literature and in engineering handbooks. The end result of his labors will be a cost schedule in a form similar to this:

Logging unit (name or number).

1. Lumber.
   - Total volume of each species or group of species listed separately.
   - Volume per diameter class for each species or group of species listed separately.
   - Total cost of delivery at the mill.
   - Cost per thousand feet for delivery at the mill.

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[1] If the operator has a mill or other equipment which can be used in exploiting this particular timber, the necessary adjustment in cost must be made. The same is true if there is other timber; he may be able to purchase and exploit with the mill and equipment required for the tract he is considering. In either event he can afford to pay more than if the one sale requires an entire set of equipment not useful elsewhere.

Same information by diameter classes.

A cost breakdown into the conventional items of felling, skidding, roading, main-line haul, overhead, etc.

2. Other products, as poles, pulpwood, veneer logs, with appropriate cost data for each.

A summary for the entire tract would follow, all averages being weighted by the quantities involved.

The job of the milling engineer is (1) to determine the cost of building and equipping the mill, of the type and size chosen, including with it the land upon which it stands, if that must be bought, plus that for such subsidiary structures and facilities as are necessary; (2) to determine the cost of its operation and maintenance; (3) to figure from the above the total and unit cost by species, size classes, etc., the timber which the forester says is on the tract and the logging engineer will deliver.[1]

Unfortunately the logger and mill man frequently use different units of measure (Chapt. VIII, Sec. 2*B*), the relationship of which must be determined so that estimates will be on a uniform basis. The final unit in a pulp mill is a ton of pulp, so estimates of cost of manufacture must show the relation between cords of wood of different sized and quality pieces and tons of pulp. In lumber manufacture the thousand feet board measure is the unit, but whether the logger and the miller are using the same board foot depends on how the estimate is made or on how the timber is paid for. If it is made and the timber is to be paid for on the basis of a log rule or volume table which gives an accurate forecast of what the logs will saw out, the difference will be immaterial and may be disregarded. If the estimate or sale basis is in terms of an inaccurate log rule, there may be considerable difference in the estimate and in what probably will be sawed out. Since most log rules in common use give minimum rather than average figures, there is apt to be an *overrun* and then the purchaser obtains more timber than the cruise figures show.[2] The amount of this *overrun* can be forecast from previous mill tallies, which show the overrun to be expected for various species, sizes of logs, and for various types of mill and dimensions of lumber. These figures are obtainable from forestry and trade literature. When the expected overrun has thus been determined in the form of a percentage for each species and size

[1] Less any special products to be sold in an unmanufactured form.

[2] Chapman and Demeritt, *Forest Mensuration*, Chapters XIII and XIV, J. B. Lyon Company, Albany, New York, 1936, give a general discussion of log rules and overrun.

of log, it has to be prorated back over the estimate and figures in the final determination of stumpage price (Sec. 3*F*).

In dealing with grades which are not always easily determinable in the field, the mill man will have to use, and presumably has previously supplied the forester and logging engineer with, tables of average percentages of grades by species and tree sizes. They are fairly well known in sawmilling circles, and numerous tables have been published in forestry and lumber trade literature which can be drawn upon if necessary (Fig. 24).

The end result of the mill man's labors will be a milling-cost table similar to that of the logging engineers. These two, added together, will show the unit and total cost of production of each size of tree, species, grade, and final product. To obtain their cost figures, both logging and milling engineers have to make use of calculations involving depreciation, salvage values, and other financial factors. They are discussed under the next heading.

D. Financial Calculations. These involve the determination of (1) the capital, fixed and working, necessary to exploit the timber;[1] (2) the cost of hiring it if it must be borrowed. The fixed capital consists of investment in conversion facilities, mills, roads, and logging equipment. The working capital is a rotating fund necessary to finance current operations during a turnover period and remains more or less fixed in amount during the life of operation (Chapt. IV, Sec. 2). The fixed capital goes into expenditures of four sorts: (1) those which last the lifetime of the operation but are of no value at its end, such as logging roads; (2) those which can be moved and have some use at the end of the operation, such as permanent equipment; (3) those put into improvements, such as buildings, which have only a salvage value; (4) those which wear out frequently and must be renewed, perhaps several times, such as trucks and tractors (Chapt. VII, Sec. 4). The capital cost of all these types must be determined with proper deductions for salvage value and additions for interest on money borrowed. In these calculations depreciation charges will have to be set up for capital recovery so that, when the operation is closed, the investor will have the sum in hand which he originally invested in these facilities (Chapt. VII, Sec. 5). The depreciation rates of logging equipment of older types is given in the Instruction for Stumpage Ap-

[1] If it is paid for in advance, the largest part of the investment will be in the timber itself, but the amount of this investment cannot be determined till the stumpage price is fixed by determination of all the other elements of the problem.

praisal.[1] More modern equipment, such as tractors, bulldozers, and internal-combustion engines, is usually depreciated to salvage value in three to five years.

It was assumed that these costs, together with overhead costs of sales, taxes, and insurance costs, were prorated to the various categories of stumpage so that their full cost of production is estimated as closely as possible. It remains to estimate the selling prices and make the necessary comparison in order to determine the price the purchaser can afford to pay for his raw material.

E. Selling Prices. This is an investigation into the probable selling prices of the final products at a future period, starting when the operation opens and extending to its conclusion. The person making it should have a considerable knowledge of past prices and some idea of business trends because his job is one of statistical research and economic analysis. Two approaches are possible: (1) to take the average prices in recent years and assume that this average will not change during the life of the proposed operation even though it is well known that it will be departed from at different times while the operation continues; (2) to attempt to forecast the probable trend of prices during the life of the operation.

In either case the prices used generally will be wholesale prices of primary manufactured products, as rough lumber rather than finished flooring. Retail prices are far less stable and less easily determined than wholesale prices, and the carrying of computations through the various operations of re-manufacture is so complicated that it is hardly worth while. The wholesale price will be at the mill or some wholesale center into which products from the region generally enter and to which the cost of delivery is known. It is easy to determine such prices from trade association reports, lumber journals, and other sources available to operators.

If the intention is to use average prices over a recent period of years, it is essential to take one period long enough to cover a full business cycle (Chapt. VIII, Sec. 3J), thus covering both high- and low-price periods. The second method, that of attempting to anticipate future prices, recognizes that there are long-term (sometimes called *secular*) price trends in the prices of forest products, which are more or less independent of business cycles. For example, the demand, and hence the prices, for railroad ties varies with the prosperity of the railroads, which in turn varies with the business cycle, but the

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[1] See Footnote 2, p. 370.

secular trend of tie demand is downward, owing to the combined factors of the increasing use of tie preservatives and of the decline in railroad mileage. The forecasting of future prices must take both secular trend and possible sequence of business cycles into consideration. Some of the background for studying secular changes is developed in Chapter XII.

The use of either of these or of their combination will depend in part on the length of the operation. Suppose at this moment (June, 1942) that an operator is considering a stumpage purchase which can be liquidated in four years. What are the prospects of changes in the price of forest products within that period? Their present average is higher, owing to war demands, than it has been in recent years. Is he justified in assuming that the present level will remain where it is, go higher, or decline? Wartime price control is now in effect so that prices are not likely to vary greatly—however long the war may last. The best opinion at the moment seems to be that it will continue for at least another two years. If the operator agrees with this forecast, he is concerned primarily with the second two-year period of his sale. He must therefore exercise his judgment on the question as to whether government price controls will remain in effect or be abolished as they were immediately after the first World War. Lapse of this control resulted in violent price fluctuations, but on the whole prices rose (Table 17). On the basis of such an analysis, he might decide on using present price levels as the basis for his calculations. If the operation instead of taking four years is to last for ten to fifteen years, the operator might well reckon with the possibility of another severe economic depression about ten years after the end of the war, which would result in price collapse (Fig. 38). He would then adjust his calculations accordingly and also give such further weight as he considered necessary to possible secular trends in demand.

F. The "Margin for Risk, Profit, and Stumpage." Having determined the prices expected for various products, grades, sizes, and species, the next step is to compare them with costs of production. This is done by a tabulation of one set of figures alongside the other, using the same breakdown as set up on pages 373–374; thus:

YELLOW PINE

Name of Unit or Item	Unit Cost	Unit Selling Price	Difference	Volume	Total Cost	Total Selling Price	Difference

The figures in this tabulation show the amount of money which the purchaser may expect to take in, out of which he must set aside a certain amount for profit and risk, the rest of which he can afford to pay for stumpage. Neglecting for the moment the question of division between these items, it is evident that the figures in the "difference" columns will vary widely, depending upon the relations of cost and value for each item. In some instances the values may be negative, indicating that to the operator the cutting and manufacture of that particular item will represent a loss and that he would be better off not to purchase it or, if he must do so in order to get all the timber, to leave it in the woods. The second difference column will indicate in what species, sizes, logging units, and so on, he may expect the most profit or the largest loss. In the light of this fact, he is able to figure a weighted average (involving the use of negative quantities if some of the stumpage which must be purchased is worth less than nothing to him), which will show him the margin per thousand (or other unit) for risk, profit, and stumpage. Each deserves a separate discussion.

1. THE RISK MARGIN. Any industry is attended by some risk which the owner must take into account. That industry involving conversion of stumpage into finished products has probably more and higher risks than the average. They involve (1) the ordinary hazards from loss by fire and other calamities; (2) those of unforeseen changes in production costs and selling prices; (3) those due to faulty estimates of quantity or quality of stumpage, intensity of road system necessary to log it, and so on.

Insurable hazards are taken care of by adding the cost of insurance to the other overhead costs, but standing timber is not insurable (Chapt. XVII, Sec. 13), and insurance on mill and logging equipment will not compensate the owner for losses due to stoppage of production even though they may replace the structures. Hazards from unforeseen changes in production costs and selling prices are uninsurable. The fact that both production costs and selling prices tend to rise and fall in unison with the business cycle (Chapt. VIII, Sec. 3*J*) cannot be depended upon too much because at times they may move in opposite directions. Risks from faulty estimates can be guarded against only by going to the expense of hiring the best experts available, acting on the principle that, although an underestimate might give the purchaser a larger profit than anticipated, an overestimate might result in no profit at all.

None of these hazards is susceptible to precise calculation for an individual operation but is related in some degree to its nature and to

the length of the turnover period, that is, the average time between the felling of a tree and the selling of the lumber made from it.[1] The more difficult the logging chance, the higher the risk margin must be. The time factors in judging the risk rate are much the same as those discussed in Section 3*E*, regarding selling price; namely, whether to expect risk elements to average out over a long period, owing to operations of the business cycle, or to take possible long-range changes into account. In any event the physical risks decline as the operation proceeds. The more timber that has been cut and turned into cash, the less that can be destroyed by fire or other agencies before it can be realized upon and the more depletion and depreciation charges have been paid off.

It is evident that the risk margin must therefore be built up from estimates of individual risks and that personal judgment as well as financial calculation enters into it. The higher the prospective purchaser puts it, the fewer chances of loss and the greater his possible profit. Therefore, presumably, he will put the rates high in his first offer (unless he fears another bidder) and be prepared to lower first the one and then the other until he feels that he can no longer afford to go lower.

2. THE PROFIT MARGIN. The profit margin is the sum per thousand feet,[2] or the percentage on capital reduced to an annual basis, that the owner thinks he ought to make after converting, selling, and collecting for all stumpage, paying all his expenses and recovering his invested[3] and working capital. The rate he sets for himself will not be less than he could obtain by lending or investing it; otherwise he would make no entrepreneurial profit and probably will be set with reference to that expected in the general run of forest enterprises similar to that in which he proposes to engage. Presumably it will be not less than 6 percent and may run to 15 percent or more. The actual profit obtained (assuming he buys the timber) will depend on the closeness of his estimates, his success in forecasting future business conditions, and the size of his risk margin, any overestimate in which being added to his profit.

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[1] A tree may be above marginal limit when cut, and two months later when the tree is ready for market may be below it (Chapt. X, Sec. 2).

[2] Or other unit in which the sale is made.

[3] If he must buy the stumpage outright for exploitation over a long period, he must allow for capital recovery by treating its purchase as a cost, by setting up a depletion account (Chapt. VII, Secs. 4 and 5), or by allowing for it in his profit margin. If he can pay for stumpage on a royalty basis, its cost becomes a current expense and does not figure in the investment at all.

3. THE STUMPAGE PRICE. This is the amount offered in the difference column (p. 377) less that reserved for risk and profit. In outright sales it represents a total sum, determined by adding the values of the different sizes, grades, etc., of timber. On royalty sales, unit values for different species, etc., are paid as the timber is actually converted.

4. APPRAISALS INVOLVING GROWTH FACTORS

Growth appraisals (Sec. 1) are of two distinct sorts: (1) those made for immature timber, which is separate and distinct from that which is mature; and (2) those where immature and mature timber are valued jointly and in relation to each other, each being an element of value in the forest as a whole. The first only is discussed in this section; the others, in Sections 5, 6, and 7.

The general process of stumpage appraisal, described in Section 3, is equally applicable to immature stands but requires the collection of additional field data and additional office calculation. The field data involve growth studies to determine how long it will take the immature timber to reach merchantable dimensions and to determine its volume and quality when it does (Chapt. XIII, Sec. 6). The office calculations consist in: (1) determining the cost of carrying the immature stock to maturity (Chapt. XIV, Sec. 10); (2) estimating its conversion costs and selling prices at that time; and (3) a determination of its stumpage value by discounting these elements to the present. The mathematics involved were outlined in Chapter VI, Section 7*B*, and in Chapter XIII, Section 8, and the practical limitations of this method which are due to the large number of unknown factors concerned were considered in Chapter XVII, Section 6. Appraisals of immature stumpage without reference to any that is mature are made most commonly as a means of determining its investment values or for settlement of damage claims (Sec. 9).

The discount method must also be used in the evaluation of immature stumpage that is mixed with mature stumpage, but its use is not so apparent and many other factors are involved along with it. It is obvious that the longer the period during which a forest is to be liquidated, the more important the young growth will be. If it is quite short, it has no value; if somewhat longer, a small amount. If the period is a rotation, even the seedlings when the operation started will have become merchantable. Therefore, the next three sections consider the appraisals of immature timber in lengthening liquidation periods for mature timber. *The problem is not to evaluate the imma-*

ture stock for itself but in its relation to that which is already merchantable.

Such appraisals may have the following more special objectives: (1) to determine the maximum realization value of the immature timber in a liquidation period, the length of which has been predetermined (Sec. 5); (2) to find a liquidation period which will permit the utilization of all immature timber which is above a certain diameter when the operation starts (Sec. 6); (3) to determine the possibilities for a sustained-yield operation (Sec. 7). Such appraisals usually are accompanied by ordinary stumpage appraisals (Sec. 4) so as to compare the financial advantages of one cutting system over another. They involve building up comparative cost structures and profits for each type of operation (Chapt. XV, Sec. 7).

5. NEAR-MERCHANTABLE TIMBER APPRAISALS

Except in forests which are completely mature, some trees or stands are increasing in volume. If the liquidation period is ten years or longer in such forests, some of the timber that was below marginal limits (Chapt. X, Sec. 2) will have become merchantable, and some that was barely merchantable will have increased in volume. For convenience both types are called *near-merchantable timber.*

The value of such timber to the operator depends upon where it lies with relation to the mature timber. If it is widely dispersed over the whole area, it will not pay to return for it after a logging unit has been worked; therefore only that portion which matures before a particular unit is reached has any value to him. If it is concentrated in units which in the normal course of logging would be operated in last, its value is at a maximum. The logging schedule as between units is arranged supposedly to obtain the lowest cost for the operation as a whole, but sometimes it may be varied without great effect. Assuming that the near-merchantable timber lies in a unit which normally would be logged early in the operation, the appraiser must balance the added cost of changing the logging sequence against the added conversion value of the extra timber thus obtained so as to determine whether it is worth logging.

In any event the unit value, even of that which is recoverable, will not have greatly increased unless there is also a price rise due to improved demand. The value of the near-merchantable timber to the operator, therefore, depends upon (1) its ratio to that of merchantable timber; (2) the length of the liquidation period. The larger the near-maturity ratio and the longer the period, the more value it has. If an

operation is to last only ten years, even though the near-maturity ratio is high, that timber which becomes mature will have but little added conversion value and the amount maturing will be small. Extend the operating period to thirty years; if the immature ratio is large, not only will a considerable amount of timber become merchantable but also much that has become merchantable will pass well beyond the marginal size and quality.

Under these conditions the operator may consider lengthening the liquidation period to realize the added value from growth, but this may afford both financial and technical difficulties. On the financial side it involves a longer period for capital recovery, which may not be justified in terms of the value of the added stumpage; and on its technical side, a somewhat different and perhaps more expensive logging system. Furthermore, if the forest contains a large amount of overmature stumpage, some of it may be lost by death and decay (Chapt. XV, Sec. 6). These difficulties sometimes may be circumvented by liquidation under a two-cut system, in which the area is worked over twice, the larger or more valuable material being taken in the first period and the smaller material, which is increasing in value the most rapidly, in the second.

6. APPRAISALS INVOLVING A SECOND CUT

Such appraisals are made to determine whether the advantages of lengthening the liquidation period and going over the forest twice to secure more stumpage are greater than those of recovering invested capital in a shorter period from a smaller amount of stumpage.

The appraiser must start with certain premises, either as to the length of two periods or as to the amount of growth he thinks may be worth waiting for. For example, he may figure 10 years to be the most financially advantageous length for ordinary liquidation operation (Sec. 3*C*) and wish to compare its financial advantages with a two-cut system covering 20 years, this being the maximum time he cares to wait. On the other hand, he may decide that, since there is a large volume of immature timber that will be merchantable in 20 years, a two-cut period of 25 years is worth considering in order to get as much of it as he can before he must recover his whole investment. However the lengths of the proposed periods are arrived at, the appraisal for ordinary liquidation purposes is conducted the same as for any other stumpage appraisal (Sec. 4); that for the two-cut system must appraise each stumpage unit in terms of its value in either the first or the second cut.

It is important to understand the nature of changes in value between cuts. Obviously all those units which are below marginal limits when the operation starts must be left to the second cut (it has no value in the first), and all those that will decline in value from death or deterioration must be removed in the first. What is between may be removed in either cut but should be assigned to the period in which it will have the most value. Part of it will be worth more in one cut, part in the other, and some will be of equal value in both because its increase in value will be balanced by its carrying charges. Those middle units whose value is increasing faster than their carrying charges should be left for the second cut; the others, removed in the first.

The object of the two-cut appraisal, therefore, is (1) to divide the timber into two groups on a basis of increase (or decrease) in volume, grade, etc.; (2) to translate these changes into value by an estimation of production costs, selling prices, etc., of these units in each period. If one assumes 10 years as the period between cuts, A the volume and B the value of a unit of stumpage in the first period, he can represent its volume and value 10 years later as $A \pm X$ and $B \pm Y$.

After the necessary figures are obtained, a tabulation is made of these values in terms of whatever stumpage units meet the needs of the problem (Sec. 3*B*), and the stumpage is allotted to the different periods according to its relative values. If the appraisal is being made to compare the financial advantages of the two-cut system with ordinary liquidation, both appraisals are discounted to present value and otherwise compared, as discussed in Chapter XV, Section 7.

In making such two-cut appraisals the same practical problems of equalizing the cut between periods may have to be faced as were discussed in Chapter XV, Section 6. Sometimes they can be circumvented by not making the periods or cuts of *exactly* the same length or size.[1]

This two-cut system may or may not be a stepping-stone to sustained yield, or some other form of forestry (Chapt. XV, Sec. 1), depending on (1) whether the operator logs in such a way that adequate reproduction establishes itself and (2) the size and amount of submarginal material left after the second cut.

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[1] For a complete study of two-cut liquidation and its comparison with ordinary liquidation under an actual set of conditions, see C. H. Stoddard, *The "Two-Cut" System of Forest Liquidation in the Lake States Region,* The Charles Lathrop Pack Forestry Foundation, Washington, D. C., 1939; the comments by W. S. Bromley, *Journal of Forestry,* Vol. 37, No. 12, p. 980, December, 1939; and J. E. Rothery, *Journal of Forestry,* Vol. 38, No. 7, p. 538, July, 1940.

7. SUSTAINED-YIELD APPRAISALS

Sustained-yield appraisals are of two sorts: those on forests already on such a basis and those to determine the value of a non-sustained-yield forest if placed on a sustained-yield basis. The latter usually are made in connection with appraisals of the same forests to determine their value, if liquidated, so as to compare the financial advantages of each operating method. In the present stage of American forestry, appraisals to determine the value of a forest for sustained-yield purposes are distinctly the more important and therefore are discussed first.

A. Appraisals To Determine Possibilities for Sustained Yield. In Chapter XV, Section 7, we saw that under sustained yield all the growth on a forest when the operation started has been liquidated by the end of the first rotation.[1] This liquidation is carried out in a series of cutting cycles, in each of which the entire forest is gone over and the timber then mature is removed.[2] These cutting cycles may be likened to the cutting periods discussed in the two-cut system (Sec. 6), and appraisal methods are the same. Growth studies attempt to forecast the volume of timber present at the beginning of each cycle, and cost studies are employed to turn the resulting volume figures into values. The many business and technical factors which will influence these cost estimates were discussed in Chapter XV, Section 6.

If cost figures can be produced which will show clearly that capital charges can be written off during the early cycles and still leave enough growing stock maturing in the later cycles to maintain a profitable operation, the advantages of sustained yield probably will have been demonstrated *for one rotation.* Later rotations will take care of themselves (Chapt. XV, Sec. 7).

B. Forests Already on Sustained Yield. Such a forest can be valued on the basis of its average annual net profit on the assumption that this profit will not change (Chapt. VI, Sec. 8, Formula 8) simply by capitalizing this income. This values both land and timber (Chapt. XIII, Sec. 6*E*). If the appraiser believes the income will increase or decline, he must capitalize on the basis of the expected change which may occur as a result of economic factors or because the amount of growing stock maturing at different times will change. Thus, if a

[1] Unless for some reason "reserve stock" is carried over into the second rotation, when it must be considered under insurance principles.

[2] With the exception of such timber as may be left to equalize cuts or as seed trees to secure reproduction.

forest is largely immature, the cut may be expected to increase in volume and value (Chapt. XV, Sec. 6*C*). If it has a surplus of mature or overmature timber, it may be expected to decline sharply when the supply is exhausted and then to rise slowly (Chapt. XV, Sec. 6*A*). The more nearly it approaches a normal forest (p. 300), the more stable its output; the income from it will be increasingly dependent on economic factors. Since no sustained-yield forest is ever or ever will be completely normal, any sound appraisal must be preceded by a physical inventory of the growing stock by age and quality classes in order to forecast changes in size and quality of future cuts. On the basis of such an appraisal, forecasts of the stability of output can be combined with the results of economic studies and the probable course of future earnings estimated.

8. DAMAGE APPRAISALS

Such appraisals are for the purpose of determining the loss to forests from natural or human causes. They may be made (1) for accounting purposes so that the owner may know the value of his property after the loss as compared with before; (2) to determine a capital loss and thus secure tax relief; (3) for settlement of insurance claims; or (4) if the damage was caused by act of another, as a basis for demanding recompense for the loss.

The methods used in appraising damages do not differ greatly with their purpose, but most damage appraisals are made with the expectation of securing recompense from the person accused of causing the damage. If the accused denies responsibility or disputes the amount of damage, the accuser may sue to collect payment. The court must decide whether the one accused is responsible and, if so, the damages he must pay.

Obviously if the one causing the damage lacks resources to pay, a suit is not worth while. If the damage is caused by an unlawful act, as setting a forest fire, the guilty party may be punished by the state, but this does nothing for the owner. The public, acting through authorized officials, also may sue for damage for the destruction of public property, with or without criminal proceedings against the offender. Since the majority of damage is caused by persons without means to pay, the loss to owners is severe and in the long run must be borne by society. Hundreds of men may be thrown out of work by the act of an irresponsible person who sets fire to a forest supporting a large lumber operation. Putting the one responsible in jail may deter him or others in the future, but that is all.

Damage suits regarding forests may arise either from the stealing of timber or other forms of trespass and from fires set either accidentally or deliberately. Fire damage cases are the most common and involve the largest sums of money and the most complex problems of valuation. The nature of these damages was discussed in Chapter XVII, Section 13. Innumerable damage suits for claims of all sorts have resulted in a large body of law and legal precedents both for determining guilt and for deciding principles of damage evaluation. Discussion of damage appraisal must be written with regard to these laws and precedents.[1]

A. Legal Principles of Damage Appraisal. Chapman[2] has admirably summarized these principles of valuation of damages, both general and forest, as follows:

a. Damages are payable in money. Compensation, not physical restoration, is required.

b. The difference in value of the property before and after the damage is the measure of damages. The value of the portion destroyed is not in itself the measure of damages, but is a means of ascertaining this difference in total value. Soil and timber are real estate. The value of this real estate as a whole, before and after the injury, is the measure of damages.

c. Damages must be appraised on the basis of the most profitable use to which a property is adapted, as indicated by the use of similar contiguous property. Sale value may or may not be a correct index of real value.

d. Values must ordinarily have a commercial or utilitarian basis, but aesthetic values, or the value of "legitimate gratification," must be recognized whenever based on elements generally accepted by the public at large. Sentimental value peculiar to the owner cannot be admitted.

e. Loss of income may be made the basis of damages; but this loss should be discounted to the present, and will then equal the loss in capital value.

f. Cost of restoration, while frequently ruled out, is admitted when shown to be less than value, or when value is difficult to determine.

g. Ordinary "profits" or income is the basis of damages. Excessive profits, which do not allow for normal losses, and speculative

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[1] From a legal viewpoint, damages may be either *ordinary*, covering only actual damage, or *punitive*, that is, in excess of it. To discourage timber stealing, the laws of some states make it possible for an owner to recover three times the stumpage value of stolen timber. Such laws do not affect valuation problems, for the true value must first be determined.

[2] H. H. Chapman, *Forest Valuation*, pp. 120–121, John Wiley and Sons, New York, 1915.

or contingent profits, which depend upon uncertain future factors, such as increased prices, are not admitted. The element of time, intervening between the damage and the realization of profit, does not bar the consideration of these profits provided they are reasonably certain to occur and are properly discounted.

h. Damages must be actual, present, imminent, or reasonably certain to occur. The damage itself may be indirect, but it must be proximate, or traceable directly to the offending cause, as, for instance, the destruction of crops, due to cattle, through leaving a gate open. The physical destruction of property by fire is an actual present damage. The cause may be a spark from a defective locomotive igniting the debris upon an improperly cleared right of way, several miles from the property destroyed. The determination of the money value of the damage is the only element of uncertainty in the process.

The following is an amplification of the above principles with illustrations of their application.

a. The person responsible for the damage is not expected to replace the property destroyed or to restore it to its original condition if destruction is partial. Frequently this would be impossible. Rather the law requires the one responsible to pay the owner a sum of money which will enable the latter to restore his property or, if physical restoration is impossible, as is nearly always true with forests, to put him in the same financial position as before the damage occurred.

b. The principle that the damage cannot be ascertained directly is illustrated in a trespass case, where all the best trees in a stand which the owner is intending to log immediately have been stolen. The stolen timber can be valued at current stumpage prices, but this does not equal the damage to the owner because the logging of the smaller trees will be more costly with the big ones gone (Chapt. X, Secs. 2 and 3) and the damage caused to the smaller timber from reckless logging by the thieves will have reduced their value still further. In extreme cases the remaining stand may not justify an immediate logging operation. The only way the loss to the owner can be determined is by an appraisal of the stand as it was before the thieves went to work and another after they had finished.[1] If the owner were practicing forestry, both appraisals would have to include unmerchantable timber, reproduction, and site condition and would have to consider the extra expense the owner would be put to for slash disposal and site

[1] Thus we can construct a basis formula for damage appraisals as follows: $D = V_1 - V_2$, in which D is the damage in money, and V_1 and V_2 the monetary value of the property before and after the damage.

restoration. The last items would be a deduction from the value of the property as it stood after the timber was stolen.

c. The principle of "most profitable use" must find its application not in theory as to what that might be but as compared with the use commonly employed. The woods on a summer estate are burned in a region where recreational use of the forest is important. The one responsible for the damage will insist that the measure of damages is the value of the timber destroyed. The owner will contend that the property as a whole has been damaged for recreational purposes and that the damage is greater than the mere loss of the timber. If he is able to substantiate his claim by reference to sale value of similar property burned and unburned, he will be able to collect on a higher basis (Sec. 9*B*). The owner of a woodland in a remote locality who happens to have a hunting cabin on it may make the same claim, but if the court finds that similar land, no differently situated as to scenic views, access, and water supply, is commonly sold on the basis of timber values, he will have to accept damages on the woodland rather than real estate basis. Decision may rest on how the land is taxed (p. 337).

d. This has to do with relation of tangible and intangible values, discussed in Chapter VIII, Section 1, where it was seen that, once an intangible value is recognized and subject to monetary evaluation, it becomes a tangible value. The intangible value of "scenery" was capable of translation into a sound basis for collection of damages for the first recreational owner in *c* but not for the second one. Sentimental values of an individual nature cannot serve as a basis for collection of damages. Whatever basis may be used to recompense an owner for the loss of a grove of old growth timber on the edge of a lake, it would have nothing to do with the sentimental value to him because he became engaged there when he was a young man.

e. Damage to a forest that is being logged results in decline or stoppage of the flow of income from the operation. The owner is justified in demanding compensation for the loss. Since the income lost could only be realized in the future, he is not entitled to the entire sum but only to that sum discounted to the present.

f. This involves the use of replacement value, which is discussed on pages 390-391.

g. The evaluation of a future income or profit (*e*) must be realistic. An owner having a stand of immature timber which will mature in fifteen years may demand, if it is destroyed completely, the expected net income discounted by that number of years, but he is not entitled to estimate the selling price on the assumption that prices will increase

250 percent, nor may the defendant assume that the timber will never be merchantable.

h. The secondary damage caused by the primary agent also requires compensation. A fire kills only half the trees in a stand, but another 25 percent dies from insect and fungous attacks as a result of it. This loss must also be included in the damages paid by the defendant.

B. Damage-Appraisal Data. Damage appraisals require the same two sorts of data as any others: (1) the physical, which has to do with quantities involved, and (2) the economic, which supplies the unit and total value for the quantities.

The requirement that a damage appraisal value the property before and after the damage (Sec. 8*Ab*) means making two appraisals at the same time unless the owner can produce a recent one which the court will accept as valid as a recent timber appraisal made by a recognized expert. If it was made several years previously, it might also serve if properly corrected for changes in volume, due to cutting and growth, and if changes in value from economic causes were allowed for.

In the absence of a useful appraisal of the property as it stood before the damage, the appraiser must contrive to reconstruct the quantitative factors and search records to determine the unit values of those quantities for his first appraisal and then appraise what remains, taking account of subsequent loss which will occur as a result of the primary destruction.

As a concrete case assume a forest concerning which there are no data. A portion of the timber has been stolen. Following this the thieves started a fire which destroyed part of the remainder. The appraiser must value the forest as it was before both trespass and fire in the light of stumpage values prevailing at that time. His second appraisal must consider the timber (1) which remains undamaged, (2) which is undestroyed, (3) which is killed but may be salvageable, (4) which probably will die as a result of the fire, and so on.

The intentions of the owner as to the use of the property will also influence his appraisal. If the owner is able to prove that he intended to make a clear cutting in the near future, both appraisals would be on that basis; if a selection or sustained-yield cutting were contemplated, both would have to be made from that standpoint. The end result is a determination of the realization values of the forest immediately before and after the fire or of some other form of monetary value which expresses the extent of the damage.

Difficult as all this is, mensuration techniques enable approximate volumes of stolen timber to be determined from stump diameters and

top lengths left on the ground. The rate of destruction of fire-killed timber by insects and fungi generally is determinable from previous studies made in similar stands, and the decline in growth, due to fire injury, to some extent is predictable. Differences in value of fire-killed and live timber are usually available from records of past sales.

C. Valuation Methods. It is not to be expected that the defendant in a damage suit, even if he admits responsibility, will agree with the plaintiff's appraisal of the damage. He is entitled at law to make up his own appraisal, which certainly will be less than that of the plaintiff not only because the damage reduced to money will differ according to the valuation methods employed but also because it is only human that the plaintiff will employ the method that will indicate the maximum damage and the defendant will use that which will give the minimum.

Thus it comes to pass that in suits where large sums of money are involved, a bored judge and a bewildered jury will listen to weeks of testimony by expert witnesses and to interminable arguments between lawyers—arguments hinging upon whether the damage should be measured by cost value, capital value, or some other kind of value. The best that can be done here is to examine the usefulness of each of these values as applied to particular situations.

The basic legal principle that the objective of damage payments is to put the plaintiff as near the same financial condition after the damage as before (Sec. 8*Ba*) implies the use of replacement value (Chapt. VIII, Sec. 1*B*) in its largest sense, but physical replacement is impossible in forests except for very young plantations, and its determination in any case first involves at least some of the other types of value, cost, capital, sale, salvage, and so on.

It is best to investigate the various aspects of replacement value for typical cases.

CASE 1. A young plantation is completely destroyed by fire. Physical restitution would be possible on the basis of replanting with stock of the same size as that destroyed; the cost of the operation may be estimated and the defendant may offer to settle on such a replacement basis. The owner may or may not be willing to accept it, depending on whether it will give him more or less damages than some other valuation method. Since such physical restitution is possible only for very young plantations or shade trees (p. 394), the alternate method is discussed in Case 2, where physical restitution is impossible.

CASE 2. An older plantation is completely destroyed by fire. There being no possibility of physical restitution, replacement value must be

determined along the lines set forth in the definition (p. 123), "the value of a forest based on what it would cost plus interest at a given rate to produce an equivalent stand in kind and volume." If the original prices prevail at the time of destruction, it is equivalent to cost value. Since this is never the case, prices prevailing at the time of destruction are used. It is therefore a modified form of cost value. The value thus having been determined, the owner is entitled to this sum.

This method is equally applicable to young plantations where restitution is possible. It is to be expected that each side of the case will argue for use of that method which is the most favorable to it. The difference in the sum obtained will depend upon the differences in the cost of planting at the two dates and upon factors having to do with the workings of compound interest.

The methods of both Case 1 and Case 2 may also be applied to young natural-growth stands, but the direct costs involved are obviously more difficult to estimate, as they must rest on the assumption that a new stand of the same kind is to be planted.[1] In any case, disputes between counsel as to actual or estimated costs are almost certain. If the owner has kept records of his actual costs, they may serve as the starting point of the legal argument. If there is no substantial difference between costs at the two periods involved, the question may arise as to whether the owner's costs were in line with the average, for, as Chapman[2] says, ". . . past costs are those incurred by an individual who may have been more efficient than the average, or less so. If his costs have exceeded the average he is rewarded for inefficiency. . . . If he has been economical, his ability is penalized."

The above cases are attempts to determine loss in terms of property values without relation to income. An income basis can also be used, and in cases of property whose value is determined by its current income the income basis is more practical. It is evident that in Cases 1 and 2 the owner could base his claim for compensation on the estimated net profit from exploitation of the plantations at maturity and therefore demand that sum discounted to the present. This is clearly a matter of determining capital value and, like all cases involving sums in the distant future, is difficult to evaluate. For isolated young

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[1] The cost value will increase with the value of the land and that of the interest rate used. Even if land value is excluded from the calculation the taxes will be higher on high-priced land. See Chapman, *op. cit.*, pp. 167–169.

[2] Chapman, *op. cit.*

stands the values obtained are likely to be thought unrealistic, and it is difficult, unless he is operating a forest on a regular cutting schedule, for an owner to prove that he intends to cut a stand at a definite age. As a stand approaches maturity and the owner's intentions are more clearly defined, the estimation of capital value becomes increasingly realistic and may afford the soundest basis for a damage suit.

CASE 3. This is a going-forest operation. In such an operation, whether it is liquidation or sustained yield, the loss of earning power is the most realistic measure of the damage. The destruction of a certain amount of timber—with proper consideration for salvage values involved—reduces the annual income of the enterprise by a certain amount for a certain number of years. What is the present value of this income loss? Argument is certain to occur about the interest rate to be used; testimony as to the average rate earned in similar enterprises should settle the matter.

9. DAMAGES TO PROTECTION, RECREATION, AND WILDLIFE FORESTS

The legal principles regarding damage do not vary with the purpose for which a forest is used, but the loss in value to be determined in forests not operated for production of timber must be stated in terms of loss according to the use to which the particular forest is put.[1] The measure of loss is that of property or income, valued in terms of protection, recreation, or wildlife, as the case may be. Due to the difficulty of measuring the values concerned (Chapt. VIII, Sec. 1, and Chapt. XVI), they may be very difficult to determine; on the other hand, at times they may be reasonably simple.

A. Protection Forests. Here the measure of the damage is the loss to the property protected. In the oversimplified case given in Chapter XVI, Section 1*B*, where a single fire destroyed the permanent producing capacity of a farm, it was 100 percent. The loss from a fire, unauthorized grazing, or similar occurrence on the watershed of a reservoir is measured in physical terms by the decrease in storage capacity of the reservoir, caused by erosion. One monetary measure of this loss is the decrease in income resulting from diminished sales of gallons of

[1] Stumpage appraisal is a part of the process but not its basis. If made, their usual purpose is to determine the salvage value of that part of the forest destroyed. Such salvageable timber as remains must be deducted from the other damage. A shade tree has been killed by a leak in a gas main; the gas company responsible is entitled either to take away cordwood in the tree or to deduct its value from their check to the owner in payment for the loss.

water or kilowatts of electricity. Since it is impracticable from an engineering standpoint to remove the silt, the loss is permanent—short of raising the height of the dam, which may not be possible. Moreover, erosion processes are cumulative and may be expected to continue either until nature heals the scars—which she may never be able to do—or until the company does so by replanting, by building check dams, or by taking other necessary steps.

The basis for evaluating the damage would therefore seem to be determinations of (1) the loss of income, (2) the replacement value of the forest, and (3) the increased loss from silting until the forest was replaced or other erosion control works were established. The total damage would be the sum of the capitalized values of all three. It goes without saying that the calculations involved until the final stage is reached are very intricate. A simpler case of the same sort would be a destroyed windbreak having as its effect the loss in crop yield to a field.

B. Recreation Forests. The damage to be determined is that to recreation-producing capacity. If the property is commercial and therefore, like a forest used for a summer tourist camp, produces an income, damage may be measured by income loss. Of course, it can also be determined in property damage. If there is loss to private recreational areas that are used only by the owner and his guests or to private estates that have no earning power, an appraisal must be based on property values. The same is true of public recreation forests, except in the rare cases where they are operated on an income-producing basis by charging fees for use.

A frequently suggested method of settlement is the difference in sale value of the damaged property before and after the event. Its usefulness depends on circumstances. It may be satisfactory in regions where recreational values are soundly established and the damage is severe enough to have an obvious effect on the usefulness of the property for estates and summer homes.

Since fire damage may look more or less serious than it actually is, the testimony of local real estate dealers, based on how they think a prospective buyer will react to the idea of purchase after the fire, should be reinforced by that of a forester who is competent to pass judgment on its actual effect on the forest. Will it impair the aesthetic value for 1, 10, or 50 years? In making such an appraisal, he must consider shrubs and wild flowers as well as the landscape value of the trees killed, in comparison with those which will probably succeed them.

Sale-value differences are very difficult to establish on public recreational areas. The land cannot be sold, and the condition of its ownership is such that it affects surrounding real estate values. If it were sold, they would be either lowered or raised (Chapt. XVI, Sec. 2*A*). It is, of course, possible to obtain some sort of "before-and-after" sale values by assuming the area to have been offered for sale immediately before and after the fire, but, in the light of the above, the figure obtained is likely to be unrealistic. If the area damaged was so small as not to affect surrounding values and was one which in both cases would have a value in private ownership, it might be of some use.

Replacement value is perhaps a better guide in most cases of property loss to recreation forests than comparative sale values. Its application does not differ from that discussed in Section 9*Ac*, but the damages shown will be greater generally because of the higher land values and taxes involved. Valuation of loss in earning power on commercial recreation areas may be capitalized the same as for other loss of earning-power cases.

A common but somewhat specialized case of recreational damage is the loss of individual shade trees from leaks in gas mains and from power lines or illegal cutting. These losses generally must be determined in terms of property damage. These determinations are difficult despite the method used—comparison of "before-and-after" sale values or theoretical replacement value. Attempts have been made to get around the difficulty by arbitrarily valuing shade trees in terms of so much a square inch of basal area or of some other size factor.

These methods may be useful in showing the relative value of trees at different sizes, growing on land of the same value, but they neglect completely the fact that the value of a shade tree depends not only on its size but also on the value of the land upon which it stands. A small shade tree in front of John Astorbilt's residence in New York is worth more than a large elm in the yard of a resident on the outskirts of a small town. Consider the property taxes involved. Theoretical replacement value can be used, but it also has its disadvantages. With modern methods of transplanting large trees now worked out to the point where it is possible successfully to move trees as large as 30 in. in diameter, many damage cases could be adequately adjusted by reliable estimate of the cost of physical replacement. The costs involved are (1) cost of removal of old trees, less salvage; (2) purchase of new trees; (3) digging, transporting, and replanting; and (4) care until the tree is successfully established in its new location.

C. Wildlife Forests. The physical measure of loss is that to the wildlife-producing power of the forest. It would produce X grouse, Y quail, and Z rabbits per annum before the fire and x grouse, y quail, and z rabbits afterwards. The problem is to determine the money value of the difference between the quantities. If it can be done successfully either in terms of an income or of a property loss, a sound valuation basis will be established. If the property is commercially operated, such a value should be determinable on an income basis. But what is the value of any game animal on a public shooting ground or on a private game preserve? It is certainly greater than its market value in a butcher shop (Chapt. XVI, Sec. 3). Property-damage considerations involved are similar to those discussed for recreational areas and commercial forests.

PART III

FORESTRY AS A PRIVATE AND A PUBLIC ENTERPRISE

In Part I we attempted to show how general economic and financial principles applied to forestry and operated in forest industries. In Part II we considered the economic value of forests and the special economic and financial factors pertaining to forestry itself. In Part III we shall discuss forestry as an enterprise under various conditions and circumstances.

Traditionally, such discussions have considered private and public forestry as entirely separate things despite their frequent and growing interrelations. We shall follow this time-honored method by discussing private forestry in Chapter XIX and public forestry in Chapter XX.

However, all the forces of modern life are tending to blur distinctions between public and private business. The growth of public assistances to private business, on the one hand, and public controls over it, on the other, is resulting in the breakdown of older classifications so that more and more economic activity is carried on in the form of cooperative enterprises, voluntary or forced, in which both the owners and the public have a part. These forms of enterprise, which are of growing importance in forestry, are discussed in Chapter XXI.

In all these chapters, particularly in the later ones, questions of general and forest policy are bound to intrude. We shall not discuss their pros and cons nor attempt decisions as to their merits since this is largely a matter of opinion, only their economic implications are considered.

CHAPTER XIX

FORESTRY AS A PRIVATE ENTERPRISE

The outstanding question regarding private forestry must be, Will it pay? Otherwise it can exist only as a marginal fringe of non-economic activity in the form of private recreational, luxury, or hobby forests or as a government-subsidized enterprise. For all practical purposes it must be made to pay from timber crops. Consequently, it does not have the wide field of objectives possible in public forests (Chapt. XX). This chapter considers forestry as an unsubsidized enterprise; subsidized enterprises are discussed in Chapter XXI.

The question, Will it pay? has different meanings to different persons. To the investor it usually means, Will it pay as much or more than other possible investments of equal risk and length of maturity? To the pulpmill owner, considering the advisability of producing his own raw material instead of buying it, it means, Which source will be cheaper and surer? To the farmer, considering the best use of a piece of land, it boils down to: Will it yield more in field crops, pasture, or woodland, or Will my farm as a whole yield more if I put more time and energy into the woodland and less somewhere else?

Abstract considerations play little part in the decisions of individuals debating in their own minds whether to embark on forestry. Each makes up his mind on the basis of his own business and financial situation. The soundness of his decision depends upon his mental outlook and the accuracy of his analysis of his own problems. He may embark on forestry under conditions where success is impossible, or he may fail to do so under conditions where the chances would be good.

Generalizations are of little value except that, as is already well known, forestry offers no inducements to the speculative, get-rich-quick type of mind and, even under the best conditions, cannot earn high rates of interest. As a business, it must be started from an existing forest (Chapt. XV) and, even as an investment, only under unusual conditions (Sec. 4*B*) can it succeed if the waiting period is long.

1. THE PRESENT STATUS OF PRIVATE FORESTRY

Despite nearly 50 years of propaganda, forestry is practiced on but a small percentage of the private woodlands of America. Table 20 is the evidence.

TABLE 20

ESTIMATED CONDITION OF PRIVATELY OWNED COMMERCIAL FOREST LANDS IN CONTINENTAL UNITED STATES IN 1938 [1]

Item	Acres	Percentage
Under intensive and extensive management (sustained yield) [2]	22,795,000	6.7
Under extensive management [3] (not sustained yield)	47,212,000	13.8
Total under management	70,007,000	20.5
Additional lands in at least partially productive condition [4]	212,726,000	62.4
Lands not in productive condition	58,176,000	17.1
Total privately owned commercial forest lands	340,909,000	100.0

1 United States Department of Agriculture, Miscellaneous Publication 381, 1940.

2 The term, as used in this table, means that the land is being managed so as at least to maintain production in sufficient quantity for commercial operation.

3 Extensive management includes a satisfactory degree of fire protection and cutting practices that are necessary to keep the land productive although production cannot be maintained at its current rate.

4 This figure includes lands bearing stands either now or potentially valuable without special effort other than fire protection on the part of the owner.

Even the overall figure,[1] showing that 20.5 percent of the private woodlands are under some form of management, appears to shrink when it is remembered that nearly 75 percent of the commercial forest in the United States is under private ownership (Table 10). The 212.726 million acres which the table classifies as at least partially productive doubtless belongs largely in one or the other of these categories and perhaps represents an outside figure of the territorial possibilities for private forestry, at least for a long term.

Many reasons are given for this poor showing, some sound, some perhaps in the nature of excuses, by those who do not wish to consider forestry seriously. We need not linger long over them. The propri-

1 In making up statistics, such as those in Table 20, much depends on where the lines are drawn between forestry in the technical sense and simply conservative cutting or accidental forestry (Sec. 9).

etors of land completely devastated in the heyday of the "cut-out-and-get-out" philosophy may be criticized for their lack of economic forethought, but, once having acted as they did, they would have lacked any economic realism if they had attempted to replant their land with great expectation of profits (Chapt. XV, Sec. 6*E*). In some cases, taxes have been a real barrier; in others, an imaginary one. The more or less forced liquidation of virgin timber in more recent times has made difficult the practice of more conservative methods in the regions where liquidation is being carried on. The timber thus produced has flooded the markets in other parts of the country and has discouraged owners from trying to grow products in competition to it. The opportunities for investment in other enterprises offering greater chances of immediate profit have resulted in lack of interest on the part of capital, and the general organization of forest industries, built up on the basis of liquidation by plants manufacturing a single product, has not been favorable to the sort of utilization most conducive to forestry practices (Sec. 7).

2. CONDITIONS FOR SUCCESS

The various conditions under which forestry is economically feasible as a private business are discussed individually in other chapters. They pertain to attitude and resources of the owner or investor, the character and location of the land and its forest growth, the nature of the markets, and the attitude of the public toward forestry. Here it is necessary only to bring them together.

1. The forest owner or the investor in forestry must have grasped the concept of continuous production and the general methods of operation necessary to obtain it and *be convinced that the use of these methods is to his advantage* (Chapt. IX, Sec. 11).

2. He must have sufficient resources to be able to borrow at low interest rates and to wait for returns, or to sacrifice part of a present return for the expectation of a greater one in the future (Chapts. IV, V, and VI).

3. The land used must be (*a*) of good growth rate; (*b*) capable of yielding products for which there is a present or at least a prospective demand within economic hauling distance (Chapt. X, Sec. 3); (*c*) inexpensive both in purchase and tax costs (Chapt. XIII, Sec. 4).

4. The stand it contains must be either immediately operable or capable of producing enough in a comparatively few years to meet costs of operations. The costs of silviculture and protection must be comparatively low (Chapt. XIV, Sec. 7, and Chapt. XV).

5. The market possibilities must be present or prospective for final and preferably also for intermediate products (Chapt. XIV). For this purpose the question of ultimate demand for forest products in general (Chapt. XII, Secs. 6 and 7) is not half so important as the prospective local or regional demand for particular products which the land in question can produce. If, for example, a new pulpmill has established itself in a region, this factor should have greater weight in calculations than that the rate of increase in pulp consumption is declining (Chapt. XII, Sec. 1*C*).

6. Public assistance to the extent of keeping taxes at reasonable levels and for providing or at least assisting in fire and trespass protection (Chapt. XVII and Sec. 8).

The more that all these conditions are favorable, the better the prospects of success; in addition, the shorter the rotation necessary to produce salable products, the better (Chapt. XIV, Sec. 12). For the individual, the better he is able to gauge how much to expend on silviculture to obtain the maximum economically justifiable final yield, the more successful he will be (Chapt. XIV, Sec. 1).

3. THE LANDOWNER, THE MANUFACTURER, AND THE INVESTOR

Individuals or corporations may have one of three economic approaches to forestry, depending upon whether they are primarily landowners, forest products manufacturers, or prospective investors. The landowner wishes to determine whether forestry affords a profitable means of utilizing his lands. The owner of a forest products conversion plant wishes to keep it supplied with raw material. The investor is looking for an outlet for his capital but owns neither forests nor conversion plants.

The landowner approach is characteristic of the forest owners who do not own manufacturing establishments (except perhaps occasionally very small plants), the operation of which is not their main business. The industrialist approach is that of the large manufacturer who owns or contemplates acquiring lands to keep his plants supplied with raw material. Even if he already owns lands, his outlook is essentially that of a manufacturer rather than of a landowner. The investor approach is that of the capitalist, large or small, who is looking for profitable employment of his capital. He may or may not already have investments in land or conversion plants but is not an owner or manager in either enterprise.

The problems as well as the viewpoints of these groups differ even though they overlap. Hence they are considered separately in the

following three sections, each group being broken down into such smaller groups as are desirable.

4. THE LANDOWNER

Forest owners, not in the industrial class,[1] may be divided into three main groups: (1) Farmers and estate owners; (2) those holding forest land as an adjunct to some non-forest enterprise, as water and power companies; (3) others owning forest land called, for lack of a better term, *independent forest owners.* Individual rather than corporate ownership is characteristic of all these groups, except water and power companies, but there are some independent forest-owning corporations.

The first three groups own forests as a part or a necessary adjunct of some other form of activity. Their economic calculations are therefore in regard to their property as a whole, and they must consider forestry not in terms of whether it is of itself profitable as a business but rather in terms of whether it can be carried on in such a way as to yield an added profit or to reduce the cost of their other operations. Independent forests must stand on their own economic legs.

A. The Farmer. A farm forest is usually a subordinate element in farm management. It is generally kept in woods simply because the soil is not suited to annual crops or pasturage. Even though it may provide him with fuel or other forest products and perhaps a surplus for occasional sale, the average farmer probably would prefer to have his woodlot in crops or pasturage if its soil is good enough to produce these more valuable products.

However, acreage in farm woodlots is probably increasing because more and more agricultural soil is proving submarginal for agriculture (p. 262). Because returns from farming are low and uncertain, farmers are under economic pressure to make their woodlands yield a continuing return. In attempting to do so they are under certain advantages and disadvantages as compared with some other owners. The advantages are: (1) Since their woodland is not their chief source of income, they are not under such heavy pressure to cut the maximum possible at any one time and may therefore build up their growing stock with little regard to compound interest considerations, nor does an annual return necessarily have to be obtained. (2) Forest work may be integrated with other jobs so that manpower and equipment, otherwise idle, may be kept busy and so that the costs may be

[1] Hereafter referred to as non-manufacturing landowners.

spread over the whole farm operation. (3) The low-grade forest products can be used in farm operations.

The disadvantages are: (1) The volume of production being small and irregular, it is difficult to market it to best advantage. (2) The lack of capital generally characteristic of non-commercial agricultural enterprises may at times force heavy cuttings regardless of present market conditions or of the future possibilities of higher yields.[1]

The solution of farm forestry problems depends not alone on "educating the farmer to the value of his woodlot" and on how to make selective cuttings but also on solving his marketing and credit difficulties (Secs. 7 and 8).

B. The Estate Owner. Forest estate owners[2] (Chapt. II, Sec. 2*B*, Chapt. IX, Sec. 6*E*, and Chapt. XVI, Sec. 2*A*) have points of economic similarity and difference with farmers. In both types of situation the forest is a subsidiary to the property as a whole. The estate owner, however, is not obliged to make his estate pay; he supports it from other sources of income; but, like the farmer, he has labor and equipment available, large or small, depending on the size and scale of his operations, which he can use in forest operations when they are not otherwise engaged. But, like the farmer, he is frequently at a marketing disadvantage because of the relatively small scale of his operations.

The average estate owner, so long as he can afford to maintain his estate, is not much inclined to indulge in real forestry (Chapt. IX, Sec. 6*E*), and, when he no longer can afford to hold, he sells it or liquidates his timber. If estate owners understood that forestry practices would not impair the recreational or scenic value of their property and would partly offset increases in taxes and in costs of estate maintenance, more estate forestry would be practiced.

Those forested estates where the present stand is young, located in regions where land, taxation, and labor costs are high, might not be able to pay a profit on a capital-investment basis but might well yield an operating profit. Better marketing facilities and local demand in estate regions than now exist would improve the opportunities (Sec. 7).

Wealthy estate owners are practically the only owners who can afford to build up a whole forest by planting on bare ground, without thought of ultimate return in terms of interest rates on invested capi-

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[1] The writer knows of an instance of a farmer who sacrificed his woodlot to send his son to a forest school.

[2] For present purposes, forests owned by hotels and clubs may be classed with estates.

tal. They can, if they wish, think in terms of building up a property for their descendants. In so doing they operate on the theory that such a property will have a greater value to their grandchildren and great grandchildren than the same sums invested in more conventional ways, even in trust funds, which, if not properly administered, decline greatly in value and, if administered with due regard to safety, yield very low interest rates. Family and estate forests have been built up in Europe on this theory for more than a century. Perhaps such forests have not earned interest on the capital invested, but the present owners are nevertheless profiting from the forethought of their ancestors.[1] To insure the proper perpetuation of such forests in America, some form of family trust may have to be set up (Chapt. III, Sec. 3).

C. Water and Power Companies. They are not the only examples of non-manufacturing forest owners whose business makes necessary or desirable the owning of forests, but they are the most important. When their forests are located on good soil and near markets, as often happens,[2] they have an excellent opportunity to practice forestry as a means of reducing costs of other operations (Chapt. XVI, Sec. 1), and this opportunity not infrequently is taken. That it is not done to a greater extent probably is due more to lack of appreciation of its possibilities or poor management than to anything else. As pointed out on page 273, the lands necessary for watershed protection in the vicinity of large cities are often so high priced and heavily taxed that, if all their costs were charged against forestry operations, the latter could not possibly show a profit; but, if the land cost and taxes are excluded from the calculation or are put in at figures based on forest values, the forestry accounts can be put on a rational basis.

D. Independent Forests. In America forests are seldom owned independent of some other form of property or enterprise—except for speculation—but much of the private forestry in Europe is carried on by owners whose chief business is producing stumpage for the open market. This type of project is, except for the long-term element, analogous to commercialized agriculture based on the sale of raw products. Forests of this type in Europe are often family enterprises, handed down from generation to generation. Their owners have a distinctly different attitude from industrial forest owners in America,

[1] For an example of such a property see: P. L. Buttrick, "The Plateau of the Thousand Cows," *American Forests*, Vol. 34, No. 7, July, 1929.

[2] When, as sometimes happens, high-grade agricultural land has to be used for protection purposes, growth rates may be obtained which are not possible on any other class of soil likely to be used for forestry purposes (Chapt. XIII, Sec. 4).

whose viewpoint is primarily that of manufacturers who are looking for raw material.[1]

Operations on an independent forest have several theoretical advantages over those on a forest owned in connection with a manufacturing plant. This is because (1) they require a lower capital outlay per unit of stumpage; (2) there is greater opportunity to build up growing stock (since output does not have to be a fixed amount to meet the capacity of a given plant); (3) in times of poor markets the shutdown expense is less; (4) there are greater possibilities for disposal of a variety of products than can be manufactured in a single plant (Sec. 8). How far these theoretical advantages would work out in practice is impossible to say. Against them is, of course, the disadvantage that a forest operated without manufacturing facilities cannot make a conversion as well as a stumpage profit.

It is possible that this form of forest ownership may become more common in the United States and with it the practice of private forestry on an increasing scale. It may evolve out of (1) speculative purchase of immature timber; (2) extension of farm forestry in woodland regions; (3) forest estates established or already existing in low-cost areas; (4) sale of land by industrial owners to individuals or corporations ready to embark on forestry enterprises.

Already there is a certain amount of speculative buying of immature timber, particularly in the South. The purchasers have learned that trees grow fast enough to figure in business calculations—lesson number one in forestry. Future action of individual purchasers may follow any one of these lines: do nothing except sell when the timber is mature; take the second step in forestry, and make further investments by applying cultural methods to increase the growth rate and thus shorten the period to maturity; decide to make the investment permanent by practicing forestry on a continuing basis. If the land is sold the purchasers may liquidate or themselves go into forestry.

In the Northeast and perhaps elsewhere, independent forests may develop out of farm or estate forestry as both classes of owners realize the possibilities, first, on land they already own; second, on purchases from their neighbors. A few owners of both classes seem consciously experimenting in this direction.

[1] Forest owners in the Douglas fir region who log their own lands and sell the logs to sawmills appear to have more the characteristics of industrial owners than of independent ones in other parts of America. In this region logging itself safely may be called an industry.

Should private forestry become more than an experiment, industrial owners might find purchasers who would take over and operate their land to the advantage of both buyers and sellers.

The matters discussed in Sections 6, 7, and 8 will affect the future of independent forests as well as of other classes.

5. THE INDUSTRIALIST

Probably forests owned by manufacturers of forest products cover a larger area (Table 10) and are better blocked up. Certainly they contain a larger volume of virgin and merchantable timber than any other class of privately owned forests. The importance of industrial ownership is indicated by the fact that private forestry is often thought of as synonymous with industrial forestry. From a national point of view the future of these lands is more important than that of all the others.

In considering the practice of forestry the industrial owner is often forced to give greater attention to whether it is possible under the conditions in which he finds himself than whether it is a desirable solution of his raw-material problem.

It has been shown (Chapts. X, Sec. 4, and Chapt. XI) that industrial ownership of forest lands originated in a desire of manufacturers to secure a supply of raw materials for a constantly lengthening period. We have seen the financial difficulties in which they were involved from overcapitalization and heavy carrying charges, on the one hand, and the profitable disposition of cutover land, on the other, were also brought out in Chapter XI. The difficulties, financial and technical, of putting a forest on a sustained-yield basis if it is being logged on a different basis were enlarged on in Chapter XV.

These difficulties do not apply equally to the two greatest forest industries, lumber and pulpwood. Therefore each is discussed separately.

A. The Lumberman. The lumberman's problem is to extricate himself from the difficulties outlined above, which are complicated by possible further decline in demand and by difficulties of getting added capital. He must look for all possible avenues of escape. Forestry is an untried venture of which the techniques are not fully worked out, and cost factors, particularly taxes, are unpredictable.

Other solutions may be to continue liquidation and, at its close, either to buy more stumpage or to invest the capital in some other

business.[1] Neither solution is ideal. Little accessible high-grade stumpage remains for sale in large blocks. The capital released by liquidation may represent salvage rather than profit and have to be reinvested at lower interest rates than desirable and without possibility of an entrepreneur's gain, or else its owners must engage in a business for which they have no training or experience.

Under present conditions, liquidation itself may not be the profitable venture it has been in the past. Intense competition, lessening demand, and higher costs may make it difficult to meet interest payments, let alone amortize debts and set up stumpage-depletion funds (Chapt. VII, Secs. 5 and 6). Under these conditions, any form of reorganization is worth while if it permits a slower rate of cutting. If financial arrangements can be made to postpone maturities, liquidation can be spaced over a longer period. The longer the liquidating period, the more possible forestry becomes (Chapt. XV). The difficulty is to secure the added capital.

It would be unwise to make predictions about the future of forestry in the lumber industry. Many companies are considering it carefully; some are attempting it tentatively; a few have definitely embarked on it. It may well be twenty years before we know whether this historic industry as a whole will unite the function of growing timber to its ancient one of cutting it. This much can be said: It is becoming acquainted with the idea of forestry and regards it in a vastly different light from years past.

B. The Pulp Manufacturer. The pulp industry has made greater progress in putting its operations on a continuing basis than has the lumber industry. Factors of a financial, technical, and perhaps of a psychological nature are responsible. The investment in a medium-sized pulpmill is far greater than in a large sawmill; consequently a longer amortization period must be allowed for (Chapt. VII, Sec. 6). This means that a raw-material supply must be assured further into the future. However, since this raw material can be of smaller dimensions, it can be grown on shorter rotation; so the problem of growing it is easier. The pulp industry as a whole is better financed than the lumber industry; the demand for its products is still increasing (Fig. 14) and, having come into the field later than the lumber industry, its initial attitude toward forestry was not so much influenced by the inexhaustibility theory.

[1] The theory that the lumber industry must practice forestry or go out of business may or may not be true, but it is beside the point. It may prefer to go out of business.

While it cannot yet be said that the pulp industry as a whole is practicing forestry on a sustained-yield basis, some companies claim to be, and most of them handle their land conservatively and try to encourage forest landowners in their territory to do so. In general, private forestry in the pulpwood field is probably further advanced than in any other branch of the forest industries.

C. Non-Land-Holding Forest Industries. Manufacturers who do not hold land are concerned with forestry because in the long run they are dependent upon its practice for their continuance in business. Their attitude toward it as customers of forest landholders may be constructive or destructive. The small sawmill man who insists on lump-sum buying, refuses to consider selective cutting, and figures on obtaining his stumpage at less than real value is not a favorable influence on farmers and estate owners who wish to keep their woodlands productive. Neither is the woodworking establishment, which refuses to consider local timber because of a perhaps unfounded prejudice against it (see also Sec. 7).

6. THE INVESTOR

Both the forest landowner and the industrialist owner are making investments when they practice forestry, but their viewpoint is different from that of the capitalist. They are essentially borrowers. In this section we are concerned with the individual or financial institution that is considering placing funds in a forestry enterprise with the expectation of receiving interest or dividends from it without assuming active management.

While investors are supposed to be concerned only with interest rates, security, length of maturity, and so on, actually there are fashions in the capital markets just as in the haberdashery trade. These fashions or attitudes of mind often block the flow of capital into new and untried fields, regardless of their potentialities. The capitalist's mental picture of a stout team's hauling home a broken-down horseless carriage made it very difficult for the early motor car manufacturers to finance their enterprises.

Two things of a somewhat similar nature have affected investors in their considerations of forestry: first, attitudes toward investments in land; second, pictures of planting a tree and waiting one hundred years before it was ready to be cut into lumber.

Until the time of the Industrial Revolution investments in land were one of the chief dependencies of the capitalist class. Men therefore invested in farms, in grazing land, and to some extent in forests, con-

sidering them as perpetually providing properties from which steady incomes could be drawn. The Industrial Revolution brought its railroads and industrial plants, offering high rates of interest and freedom from entrepreneurial responsibilities. Land as an investment gave place to land as a speculation with good prospects of a high unearned increment. Mortgages were considered relatively short term investments covered by present value of the property and were financed largely from local capital sources. In this mental climate, investments in forest liquidation were highly regarded. Those in forest growing, an enterprise not offering high profits at best, and considered as they were on a 100-year-wait basis, received no consideration.

The heyday of the industrial period is over; economic and social changes of unknown direction and extent are in the making. This is not the first time the world has faced a future which it could not forecast, and instinctively it is turning liquid wealth into land as it has at similar periods in the past. Such investment means little if the land is not productive.

Forestry as an investment possibility does not consist in buying land and expecting nature to produce a crop unaided. It does not even consist in planting large areas of denuded lands and waiting a century for a crop to mature. It is rather an investment in putting existing forest lands on a basis of continuous production. This does not involve a waiting period longer than is required in many other kinds of investment that are commonly considered good risks. If investors who are looking for opportunities to put their money in lands under conditions where profits are possible should realize this, both they and the public should be the gainers.

7. ORGANIZATION OF THE FOREST INDUSTRIES AS RELATED TO PRIVATE FORESTRY

References have been made in previous sections to the fact that the forest industries are not organized in a fashion entirely conducive to the practice of forestry either as a land or as an industrial enterprise. The purpose of this section is to deal briefly with its failings in this respect and with its possible reorganization on a more favorable basis.

These industries are dominated largely by individuals and firms who either own forest land to feed their own conversion plants, operated on a liquidation basis, or buy stumpage from private forest owners also willing to liquidate. Industrial ownership is generally characteristic of large producing regions; stumpage purchases, of the small ones (Chapt. X, Sec. 5). Manufacturing plants of all kinds usually are

equipped to manufacture only one major product: lumber, pulp and paper products, naval stores, plywood, or cooperage. Trade organizations generally are based on the nature of the products manufactured, as lumber manufacturers, plywood manufacturers. Forest owners, regardless of the class to which they belong, have almost no organization as such. Exceptions are occasional fire protective associations and a few local producers' cooperatives, the latter mostly among woodlot owners.

From the point of view of private forestry this set-up has two outstanding disadvantages, one of which applies chiefly to industrial owners; the other, to non-manufacturing ones. The plants are equipped to produce a single or at best a narrow range of products, but the forest by its very nature produces materials suited to a wide range of uses. A merchantable stand of slash or longleaf pine contains trees suitable for poles, lumber, railroad ties, pulpwood, and naval stores. Disregarding the complicated matter of values for naval stores, the stumpage values for the others are usually in descending order although, of course, not all trees in a stand are suitable for the higher uses. Telephone poles can be obtained only from straight trees meeting certain standards as to top and bottom diameters, but the lower-valued products can be made from the higher-valued trees.

The manufacturer of individual products is at a disadvantage in disposing of trees that ought to be cut for silvicultural reasons but which cannot be used for his product. Neither is he organized to dispose efficiently of the trees that are more valuable for a higher grade of product than his own; so he may be compelled to use them himself. Thus a lumberman may make lumber out of pole trees and leave standing crooked trees useful for pulpwood, which for the good of his forest should be cut. The pulp manufacturer can use practically everything but by so doing loses the profits possible from larger-sized or higher-grade trees.

In other words, forest utilization under industrial ownership is not integrated. It is impossible to integrate physically manufacturing plants such as sawmills and pulpmills, but it might come about from unified ownership and management, able to route trees and logs from the stump to the plant, which is equipped to realize the most from them, or it might be worked out cooperatively between plants under independent ownership in the same region. With this problem industrial forestry has to wrestle.

The non-manufacturing forest owner is theoretically in a position to practice integrated utilization by grading his trees and logs according to the products for which they are the most valuable and selling

pole trees to pole yards, saw logs to sawmills, tops and defective trees to pulpmills and so on. Practically, unless he is prepared to do his own logging, this is not easy. The sawmill stumpage buyer wants all the logs he can get from the area and frequently will not bid otherwise; the pulp contractor likewise wants to buy everything he can use and will pay only at a price justified by the selling price of his final product. Even if the owner does his own logging, unless his volume of material is considerable, he may run into the difficulty and extra costs of dealing with several plants, none of them particularly interested in buying in very small quantities.

Integrating utilization is a forestry and industrial problem in all forest regions. In farm and second-growth regions of the Northeast it is complicated by the small size of the average forest holding and by the nature of the industries and marketing practices, which are almost entirely of the stumpage or log-buying type. They are confined mostly to portable sawmills and small woodworking establishments, the former preferring to purchase for a lump sum all the sawlog stumpage on a tract, the second wanting limited quantities of high-grade logs of valuable species. Larger woodworking and finishing plants, wanting materials in quantities and of definite grades, usually import them from regions still producing virgin timber. The small owner is at a disadvantage in all these markets. The sawmill man wants to buy everything at a lump sum and seldom will consider selective cutting. The cutting and transporting of a few selected logs to a special product plant is expensive, and the larger plants will not buy local material in small lots.

These problems must be solved by the development of merchandizing methods, enabling individual owners to sell varied products in small quantities at advantageous prices. A step already taken in a few places in the Northeast is the development of cooperative forestry through the formation by small owners of producers' cooperatives which, by enabling them to pool their cut, improves their bargaining position with manufacturing plants. These cooperatives may function simply as marketing agencies or may go further and standardize grades, require owners to cut in accordance with forestry principles, furnish technical advice, or even operate cooperative manufacturing plants, as the members choose.

It is probable that development of organized sources of supply of standardized materials by cooperative or other methods would be responsible for greater sales, improved plants, and a gradual revival of forest industries in the regions, and consequently much more satisfactory conditions for private forestry than exist at present.

In the South where large pulpmills recently have been established, the companies have tried to work out a system under which private owners would find it to their financial advantage to handle their woodlands on a forestry basis, and the companies would thus be able to avoid the heavy expense of acquiring large forest areas. If the other forest industries should cooperate both with landowners and with the pulpmills, a system of forest production and integrated utilization might evolve to the profit of the entire region.

Integrated utilization and cooperative marketing are among the most immediate problems of private forestry. The possibilities of increased utilization through search for new products, better manufacturing and merchandizing methods, and reorganization of the forest industries were discussed in Chapter XII, Section 6. Success or failure of such endeavors would go far toward determining the success or failure of private forestry.

8. THE PUBLIC ASPECTS OF PRIVATE FORESTRY

It is recognized increasingly that forests are a public utility. As such, the public has an interest in their well-being and, if it sees fit, may regulate their use (Chapt. XXI). In view of this public interest, the public owes it to the forest owner and to itself to do nothing which prevents or makes more difficult the practice of private forestry. A state which taxes forest land unreasonably, does nothing to make easier the costs of fire protection or to lessen the danger of timber stealing or grazing trespass, is not in a very good position to complain if owners liquidate their holdings as fast as possible and abandon ownership rather than pay taxes on worthless stumplands. Failure to do this minimum for private owners casts the entire burden back on the public itself, leaving it two choices. It may throw up its hands and suffer permanent economic loss or it may institute salvage proceedings through vast reforestation programs at great present expense, the major returns from which will be available only to future generations who also will have to pay interest on the restoration costs.

The public can of course go much further in assisting private forestry; it can provide technical information and assistance, grant subsidies, direct or indirect, lend capital, provide credit. Perhaps the owner has no right to demand such services of the public; yet it may be in the public's own interest to proffer them as a means of preventing forest destruction with its economic consequences.

There are those who question whether private forestry can function in America on any extended scale as an unsubsidized enterprise. It is

too early to know. If time proves that it cannot, the public will have to decide between public ownership and public subsidies or some combination of the two. These matters are discussed further in Chapter XXI.

9. THE FUTURE OF PRIVATE FORESTRY

It would be a brave man who would make predictions as to how much private forestry will be practiced in the future, how it will be organized, or how fast it will be taken up. As yet it is a tentative venture even for those engaged in it. The fact that hundreds of owners of all classes are becoming familiar with the objectives of the forester and are getting some idea of his technics is encouraging. It is well to remember that no hard and fast line can be drawn between conservative logging practices merely intended to prevent complete forest destruction and technical forestry, designed to keep the forest continuously productive. Some of these conservative practices may be so crude or illconceived as to be of little value, but out of them may grow sound forestry measures. If the experience of more than a century in Europe is any guide, private forestry, no matter how widely it may be practiced, will seldom meet the technical standards desired by foresters in the public employ.

CHAPTER XX

ECONOMICS OF PUBLIC FORESTS

Public forestry in its broadest sense covers three distinct fields: (1) forest ownership by public bodies; (2) public assistance, direct or indirect, to private forestry; (3) public controls, immediate or remote, over management of private forests, commonly called *public regulation*. This chapter deals only with publicly owned forests; public assistance and regulation are considered in Chapter XXI.

In democratic countries, public forestry is practiced as a matter of public policy because private owners are (or are supposed to be) unwilling to handle forests to the best interests of the public. The extent, kind, and nature of management of public forests depends upon the problems they are required to solve, the financial strength, the technical and administrative competence, and the integrity of the governments operating them. The less satisfactory the operation of private forests, the more the need for public ones, the stronger the government financially, and the more farsighted its policies, the more the needs will be met.

1. LEGAL ASPECTS

Historically, public forests have come into being (1) on land already owned by governments either as general public land or for some special purpose, (2) on land acquired with the definite intention of using it for forestry. Legislative or administrative authority is usually necessary to set aside public land for public forests

The legal bases for acquisition of land for public forests were set forth on page 259, which shows that governments have the inherent right to acquire land for public purposes and even democratic government may take possession of such land under due process of law and upon payment of compensation to the owners. In America, the power to acquire and use land for public purposes is possessed by federal, state, and local governments; consequently we have national, state, and local public forests, the last usually called *community forests*. Permissive legislation is usually required for the purchase of public forests before the general powers of government can come into use for the purpose. In America the state is the basic unit of government;

consequently, before the federal government can purchase land for forests, each state must authorize such purchases within its own boundaries, and the states must generally grant the power, either by general statute or by legislation, to cover special cases. Sometimes such legislation does not grant the right of condemnation and the private owner is not obliged to part with his land if he does not so desire.

2. ORIGIN AND HISTORY

A. Early History. Because they are generally of inferior immediate value, forest lands have been the last lands, except deserts, to pass into private ownership. Tribes and, later, primitive villages valued the forest for its game and pasturage and as a source of fuel and construction materials that they needed. Land so held is called *common land* because in legal theory it is the undivided property of all the inhabitants of the district. Such control as is judged necessary, chiefly to prevent strangers from using it, is exercised by the people as a whole or by their leaders.

Forests and grazing land in remote parts of the world, inhabited by primitive people, are still largely held in common. Remains of this system exist in Europe and traces of the idea still linger in America.[1] As populations increase and differentiate in economic and political strength, demands on the forest increase. The more powerful members of the group attempt to assert ownership rights over it and their claims are opposed by the others. Out of this struggle, amply recorded in the history of medieval Europe, grew modern ideas of private forests, public forests, forests as a public utility, public control over private forests. In this contest, the lords and nobles often won, and the land became private property. When the peasants won, the land became legally recognized as communal forests (Sec. 2*D*) in which each citizen had the right to use the products of the forest as he saw fit. Often compromises resulted, and private title to the land was recognized but the right of fuel cutting and pasturage by local inhabitants was confirmed and forests were thus legally recognized as a public utility.

Out of the confusion of medieval times grew local governments more or less democratic in nature, along with highly autocratic national monarchies. Both were faced with the problem of regulating the confused pattern of *forest rights* which had made orderly use of the for-

[1] Chapter XI, Section 1. Also as illustrated by laws in certain states requiring a forest owner to fence *out* his neighbors' cattle, the general disregard for "No trespass" signs on woodland areas, and the often repeated response of picnickers to remonstrance of landowners: "I didn't know anyone owned the woods."

ests impossible.[1] Local governments had to restrict rights, which, if an individual used them to extremes, meant destruction of the forest and loss to the community. Central governments had to protect the interests of both landholders and rightholders. Thus public regulation of forests came into being (Chapt. XXI).

More and more private forests gravitated into the hands of royal families, but the period at the end of the French Revolution saw many of them nationalized by confiscation or managed for public purposes. Thus national forests were born. Since early in the nineteenth century, most European governments have extended management controls over both private and communal forests in response to various needs and in varying degrees. These modern controls are based on forestry principles and designed to keep the forests productive rather than to check abuse due to misuse of forest rights, as the earlier controls (Chapt. XXI, Sec. 4).

Heavy cutting and uncontrolled grazing on private and communal forests, which could only be controlled by nationalization, caused the French government to institute an ambitious program of purchasing protection forests about the middle of the nineteenth century. Other countries have done likewise, to varying degrees.

B. National Forests in America. The early breaking down of systems of common land holding and public regulation in America (Chapt. XI, Sec. 1) and the fact that the national government early came into possession of enormous areas of forest land, reversed the European sequence and, when economic conditions forced the consideration of forestry, caused it to be taken up largely as a national or a state matter rather than a local one.

Its early history is well known.[2] At first the federal government regarded its forests and public lands as a financial asset, and receipts from land sales went far toward the support of the new government.[3]

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[1] P. L. Buttrick, "Forest Rights in Europe," *Journal of Forestry,* Vol. XXIV, No. 2, p. 141, February, 1926, and W. N. Sparhawk, *Forest Rights in Foreign Countries with Special Reference to Grazing Rights,* Circular 456, United States Department of Agriculture, 1937.

[2] It is written up in detail in J. Ise, *The United States Forest Policy,* Yale University Press, New Haven, Connecticut, 1920, and J. Cameron, *The Development of Governmental Forest Control in the United States,* Johns Hopkins Press, Baltimore, Maryland, 1928.

[3] It is interesting to note that Canada and its provinces, which also had vast areas of public forest land, adopted the practice (and still retains it) of selling stumpage under long-term contracts that contain minimum provisions for fire and other protection but retained title to the land. This system stands between our older system of selling land and the new one of national forests.

Later this policy was modified in favor of the more social one of making gifts and sales at nominal prices to encourage settlement. Although the government was often lax in protecting public domain, it never allowed a legalized structure of forest rights to grow up, such as arose in Europe; so its baneful effects on forest management have been spared us, and our forests have never assumed the status of common lands (Sec. 2*A*). However, it is still possible that grazing rights may establish themselves on public lands of various kinds in the West.[1]

Three-quarters of a century of forest devastation aroused popular fear for the future and initiated the forestry movement. Its leaders advocated what doubtless seemed at the time the measure most easily obtainable[2]—the retention of large remaining areas of public timber in public ownership. It took twenty years to obtain results, but the Act of March 3, 1891, finally authorized the President to make timber reserves[3] from the public domain. Over 200 million acres were thus set aside before Congress, alarmed at the extent of the area and fearful that its withdrawal threatened the "development" of the West, revoked the measure. Subsequent additions from this source have been by acts of Congress. In 1911, under the Weeks Law, Congress authorized the purchase of land on the headwaters of navigable streams in the East where there were no federal public lands. Later acts, notably the Clark-McNary Law of 1924, permitted purchase of land in other parts of the country and not alone on the headwaters of navigable rivers. The Act of 1905, placing the national forests under the administration of a technical service, is another landmark; without such management they would be more or less worthless for public purposes.

In 1938[4] the gross area of national forests was 227,280,025 acres, the net was 175,238,168 acres, the difference being accounted for by land within forest boundaries, privately held or in other forms of public ownership. Of this net area, a total of 15,672,572 acres has been bought; all but a few hundred thousand acres are in the East. Established purchase areas amount to 52.5 million acres, of which less than 2 million lie in the West.

By no means all of this land is forested. Of the 122 million forested

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[1] P. L. Buttrick, "Politics and Perpetual Rights, Some Aspects of Grazing on the National Forest," *Journal of Forestry*, Vol. XXVI, No. 1, p. 34, January, 1928, and O. Butler, "The Editors Log," *American Forests*, Vol. 47, No. 6, June, 1941.

[2] See last part of Chapter XIII, Section 3, for discussion of forces and motives, economic and other, that play a part in such struggles.

[3] Later called national forests.

[4] *Statistical Abstract of the United States*, Tables 709–710, 1939.

acres, only 81.5 million acres are classified as commercial;[1] to non-commercial is added open range, desert, land above timber line, or otherwise unproductive land. Most of the eastern forests are on cut-over land, much of it so badly devastated that it requires replanting.

Aside from any question of their ultimate extension (Sec. 8), most of the national forests need boundary adjustments and the extinction of many interior holdings in order that they may be administered successfully from the standpoint of timber management and protection.

C. State Forests. Although the beginnings of state forests in America antedate the national forests, considered collectively, their development has been much slower and far more spotty. Few states have well developed systems; holdings of many are nominal or non-existent. The earliest were in New York, where, beginning in the 1870's, substantial areas were acquired or set aside from state public lands in the Adirondack and Catskill Mountains. Their management has turned out to be along recreation lines and they are operated as parks (Chapt. XVI, Sec. 2*C*). Much more recently the state has embarked on a policy of buying up and planting abandoned farm land to be used for state forests. The total area of state forests of all classes in New York state is now about 2.75 million acres.[2]

Pennsylvania, the second state to start a forest-acquisition program, began in 1898. Its state forests now cover over 1.65 million acres. Its early history was more influenced by forestry than by recreation concepts.

Most state forests are of much more recent date, but 39 states now have them. They vary from a few hundred acres to 5.75 million acres in Minnesota. The national total is about 13.5 million acres, most of which lie in the Northeastern and Lake States.[3] This does not cover all state-owned forest land, which also includes state parks, wildlife areas, unassigned public lands, and military reserves, altogether totaling some 5.5 million acres.[4]

States have acquired their forests in various ways. In the eastern states it has been largely by purchase, supplemented by gifts—little of the states' own public land remained in their possession when the forestry movement started. The Lake States had most of their state

[1] *National Forest Economy*, p. 98.

[2] All statistics of area in this subsection, unless otherwise stated, are from Table 1, Miscellaneous Publication 373, United States Department of Agriculture, entitled *State Forests for Public Use*, dated 1940.

[3] *National Forest Economy*, p. 98.

[4] *Ibid.*

forests forced upon them by the abandonment of cutover lands. Some of the western states have set aside as state forests portions of federal grants from the public domain, made to them when they attained statehood. The federal government has also given to certain states long-term leases of lands acquired under its resettlement program, which are managed as state forests.[1] Other forms of federal aid to states in acquiring forests are mentioned elsewhere.

As might be expected, state forests are generally on cutover lands, varying from completely denuded areas as the majority of those of the Lake States, to second growth in various stages of development in the older states of the Northeast. Some of the western ones, whose origin was in federal grants from the public domain, contain merchantable timber. These lands are generally in small blocks mixed in with federal or other lands and cannot easily be handled as separate units. Objectives, problems, forms and standards of administration, differ widely between states, as do the degree of accomplishments. Some have well-defined policies as to management and future extensions; in others they are rather vague. Probably no state, in the opinion of its own forestry authorities, has a sufficient area of state forest to meet its needs. The future of state forests is discussed in Section 8.

D. Community Forests.[2] Community forests[3] may belong to any political unit from a county to a school district. In a county, they may, as in Wisconsin, approximate state forests in size. In a school district, they are bound to be small. Classified by primary objectives, they fall into four groups: timber production, watershed protection, recreation, and land salvage.

Only the first of these is historically related to the communal forests[4] of Europe. A few New England towns, where the tradition of common land ownership lingers (Sec. 2*A*), have operated such forests for a long time[5] and have made a profit on their operation. Propaganda campaigns have extended the number of towns that attempt it.

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[1] P. L. Buttrick, "The Land Utilization Program of the United States Resettlement Administration Program in the Northeast," *Journal of Forestry*, Vol. 36, No. 2, p. 117, February, 1938.

[2] General references: C. R. Tillotson, "Community Forests," Copeland Report, Vol. I, pp. 843–850, 1933, and N. C. Brown, "Community Forests: Their Place in the American Forestry Program," *Journal of Forestry*, Vol. 39, No. 2, p. 171, February, 1941.

[3] Often called *communal, municipal, town,* or *local* public forests.

[4] From the French *commune,* the smallest political unit in France and Switzerland, analogous to towns or townships in the United States.

[5] Copeland Report, Vol. I, p. 844.

Perhaps considering the difficulties involved, the profit idea has been overstressed in these campaigns (Sec. 4*I*).

Forests for protection of municipal water supplies constitute the largest number, if not the largest area, of community forests in America and are very common in the eastern United States. Municipal woodland parks are also common but are less extensive territorially than watershed forests.

County forests are confined largely to woodland parks in counties surrounding metropolitan areas, such as Cook County, Illinois, on the outskirts of Chicago, and Westchester County on the outskirts of New York, and in the state of Wisconsin, where their primary purpose is to restore to forest large areas of cutover lands which have reverted to public ownership because of tax delinquency. The same problem is handled in other Lake States directly by the state governments themselves.

Management of community forests may lie entirely with the community concerned or may be under considerable state supervision, as in Wisconsin where state financial assistance is also given.[1] Most states offer technical assistance and some, notably Massachusetts, have adopted facilitating legislation.

It is estimated (1940) that there are 1648 community forests in the United States, having a total of 4 million acres, of which those of Wisconsin cover approximately 1.75 million acres.[2]

E. Public Institutional and Trust Forests. Public institutions, a state university, for example, and certain classes of the population legally set apart from the general body of citizens, may own or may have held in trust for them, forests which they manage or which are managed for them by public agencies. The Indian forests on federal Indian reservations [3] are the most important of the trust forests.[4]

Such forests obviously must be managed principally for the benefit of the institution or the class of population for which the trust is set up.

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[1] F. B. Trenk, *The County Forests of Wisconsin and the Wisconsin Forest Crop and Tax Laws*, p. 26, 1938, Wisconsin Conservation Department, Madison.

[2] Brown, *op. cit.*

[3] For complete discussion of Indian forests see H. B. Steer, "The Indian Forests," Copeland Report, Vol. I, pp. 607–632, 1933. For recent data, see J. D. Coffman, "Forestry in the Department of the Interior," *Journal of Forestry*, Vol. 39, No. 2, p. 85, February, 1941.

[4] The total area of forests on federal Indian reservations is 12 million acres; its commercial area, 6.4. They are managed as an integral part of the reservations, which total 55 million acres. *National Forest Economy*, p. 98, and Coffman, *op. cit.*

Benefits to the general public accrue in somewhat the same fashion as do those from private forests (Chapt. IX, Sec. 9). A university forest, if operated on a revenue-producing basis, reduces the public appropriation necessary by the amount of profit made. An Indian forest, operated to support the Indians on a reservation, does the same, and, since many of them are large, they often provide important watershed protection, local employment to others besides Indians, and other public benefits.

Those in charge of institutional or trust forests are in duty bound to consider the immediate as well as the future welfare of the institution or beneficiaries of the trust. This often operates, as does the profit motive on private forests, to make difficult the necessary investments for future yields and may even force what amounts to heavy liquidation cutting.

The future of forests of this type in the United States is unknown. With a drying up of other sources of trust investment and a better understanding of forestry as an investment, such forests may increase in future. The future of the Indian forests is bound up with general policies of handling Indian problems.

3. PROBLEMS AND POLICIES

The problems of public forests, like those of all other public enterprises, are of two orders: (1) What are the objectives of the enterprise? (2) How are they to be realized?

To illustrate: Suppose a state has two distinct forest districts, one in its mountain terrain on the headwaters of its streams and another on the coastal plain. The forests in the mountains are non-commercial but are being destroyed by overgrazing and clearing for unprofitable agriculture. The resulting erosion is responsible for floods, choked stream beds, and interrupted navigation in the adjoining coastal plain. Here the forests are valuable commercially but rapidly are being destroyed by overcutting, thus destroying the economic base of the region. In both instances the only solution seems to be large-scale purchases for public forests. The objective to be sought in Case 1 is the establishment of a protection forest and the resettlement of the mountain population; that in Case 2 is the establishment of a timber-producing forest in time to head off liquidation and keep the forest industries going. The state is financially unable to act effectively in both regions at once. Which should it attack first?

The question is one of public policy. It may be decided in the light of the paramount social and economic values involved or by the politi-

cal strength of the regions concerned, or it may result in a compromise, under which an inadequate program is set up in both regions. Decision having been made, problems of the second order arise; first, as to the precise lands to be purchased and the order in which they should be taken over; second, as to how they should be managed. They also call for policy decisions, but of a lesser order, which are more of an administrative nature. The basic economics involved do not differ essentially from those encountered in private forestry.

Nevertheless there are certain differences, chiefly of an investment nature, between public and private forestry operations, not discussed in earlier chapters, which affect particularly land acquisition and early-development stages. In private business the criterion is profit. Both capital and current expenditures are made in relation to the expected return. If a fixed investment of $15 million is required to construct a pulpmill that will earn 5 percent on the investment, the expenditure is made, provided the capital can be obtained. If only $10 million can be borrowed, the project is dropped. In public business, direct relationship between expenditure and return seldom prevails. In the hypothetical case above, suppose the mountain problem could be solved at a public expenditure of $50 million if expended within a 10-year period. But, since both erosion and forest destruction are likely to be an accelerating process, the longer the problem is neglected, the more the flood damages increase. Suppose that the state is willing to spend only $500,000 a year. At such a rate the remedy may never catch up with the disease, or, if it did, the patient would have suffered longer than necessary and the hospital bill increased to correspond.

Private capital must also regulate with reasonable precision the proportion of its expenditures for different items necessary to the end result—financial profit. Public bodies may fail to do so without necessarily going into receivership but, nevertheless, suffer financial and other losses if they do not. The matter is of particular importance as it relates to a balanced program of acquisition and development. Disproportionate sums spent will cripple a program. It does not matter whether the disproportion is caused by desire to meet the wishes of the public or by lack of forethought on the part of the planners. Large purchases, particularly of deforested land, not accompanied by adequate funds for development, accomplish little except possibly the readjustment of tax burdens and the prevention of uneconomic use of land that might have occurred if it had remained in private hands. Unless there is money for its development, even well-timbered lands contribute little and at best are only "timber reserves" (Sec. 4*B*).

On the other hand, heavy development on small areas, no matter what their condition, often goes beyond the point justified by resultant economic or social gains. A few small public forests, scattered over a wide area and not located or managed with reference to economic objectives, discussed in Section 4, are no great public asset no matter how well they are developed.

Usually acquisition programs, both federal and state, that have begun buying on a large scale have gone ahead faster than corresponding development programs. In certain cases, especially during the late depression, when relief funds and labor were abundant, some of the smaller public forests had more development than could be justified in terms of economic returns.

The practical necessity of keeping down costs applies to public forestry as well as to private. Since public appropriations for forestry are usually smaller than they should be to accomplish its objectives, foresters have had to squeeze 110 cents out of every 100 in order to fulfil their responsibilities to the public. They have shown an ability to cut costs of management and equipment that compares favorably with that in private industry. Their only reward has been the approbation of their fellows in the profession and the consciousness of a job well done.

4. OBJECTIVES

The general objectives of public forests are well known: watershed protection, timber production, and the others. In any large country the chances are that, if there is a need for public forests at all, they will be needed for all these purposes plus other more specialized ones. These needs will not appear necessarily at the same time or in the same parts of the country, will not be of equal importance, or will not be equally easy to meet. As time goes on, they will tend generally to expand and diversify. The professional and public attitude toward them changes as does the financial power to meet them. Often this has forced minor problems to be attacked before major ones and resulted in neither one's being fully solved. At the start of a forestry movement, a government naturally takes the course of setting up public forests on forest lands that it already owns, whether they are best suited to this purpose or not, later extending its program to purchasing others, often those that are the cheapest rather than the best suited to the desired objective. The whole process is an evolutionary one which has nowhere come to an end, nor is it likely to.

The best way to examine it and study its economic and social implications is to discuss separately the objectives somewhat as they

have been introduced in America. Following is the list of these objectives.

A. Timber for government use.
B. Reserves for public use.
C. A continuous supply of forest products for public use.
D. Watershed protection and erosion control.
E. Public recreation and wildlife conservation.
F. Sustaining or restoring regional economies.
G. Demonstration or research.
H. National defense (in a strictly military sense).
I. As a public money-making enterprise (discussed in Sec. 5).
J. Multiple purposes.

A. Timber for Government Use. The only American forests established for this purpose were to provide for an adequate supply of construction timber for its infant navy. In the days of wooden ships, the live oak (*Quercus virginiana,* Miller), growing only along the South Atlantic and Gulf coasts, had special value as framing timber for warships. In 1799 the first live oak forests were purchased in Georgia; when Florida came into American possession, others were established on its newly acquired public lands. With the coming of steel ships the reserves were forgotten, but parts of them later became national forests.[1] The development of a modern system of public forests has made special government supply forests unnecessary although they may be needed for other exclusively governmental purposes (Sec. 4*H*).

B. Timber Reserves for Public Use. When the first timber reserves were set up under the Law of March 3, 1891 (Sec. 2*B*), they were popularly considered to be what their name implied—a reserve for public use at such time as private timber was exhausted. Only gradually did the more dynamic objective of continuous production arise, finally to receive full recognition when the reserves were organized as national forests under the management of the Forest Service. In the absence of any immediate need or means of exploiting public timber resources, a reserve policy as a means of protecting them for the future is economically justified, just as it is for public oil and mineral reserves. Whatever their ultimate value, they have an unfavorable effect on local economy while they remain in cold storage.[2] Neverthe-

[1] For detailed history see Ise, *op. cit.*, p. 22, and Cameron, *op. cit.*, Chapts. IV and V.

[2] Much of the early objection to the western national forests was because actually they did block economic developments in their vicinity until the reserve concept was modified.

less, for economic reasons the Forest Service has not yet been able to discard the reserve concept entirely (Sec. 6*B*).

C. Continuous Supply of Forest Products for Public Use. The supplying of forest products for public use is usually one of the objectives of public forests and is legally recognized as such on the national forests and at least inferred on state and most community forests. As a sole objective, if it is to be successful economically, it implies the use only of lands physically and economically suited to the purpose. It may therefore conflict with other objectives, not requiring lands so suited.

Out of this objective also grow questions of policy as to forest products prices, relations with private producers, and other questions of a like nature, discussed in Sections 5 and 6. Except as they affect long-range plans, these questions are at present somewhat academic. Public forests are not able now, nor will they be able for a long time, to supply any great volume of products as compared with total consumption, although certain of the more favored national forests supply most of the local needs of the nearby communities. The national forests were carved from the public domain after most of the best timberland had passed into private ownership. Much of the commercial stumpage they hold is at present economically inaccessible. The newer national and most of the state forests have been established on cutover or barren land.

Although timber production has been popularly endorsed as an objective, it has been thought of largely as a matter for the distant future, without much consideration of how far the public should go in providing timber for its later needs, at what period it should be prepared to meet them, or whether it was acquiring the lands best suited to the purpose (see also Sec. 4*F*).

D. Watershed Protection and Erosion Control. The protection of watersheds was one of the legally established objectives of the early national and state forests. The Weeks Law (Sec. 2*B*), which first authorized land purchases for national forests, authorized them only for the protection of headwaters of navigable streams in the East which were being deforested rapidly at the time. Later acts legalized similar purchases in the West to supplement the effectiveness of existing national forests. A protection objective may or may not involve acquiring lands suited economically to timber production. In the East it often does. In the West much of the forest land most desirable for this protection is of indifferent value for timber (Chapt. IX, Sec. 6*A*).

On the whole, public purchases to protect watersheds have received more popular support than have purchases for some other purposes because the public has usually been more able to understand the urgency of such protection and because the watersheds usually were cheap[1] (Sec. 6*A*). For other economic factors of protection forests see Chapter XVI, Section 1.

The following tabulation[2] gives the status of publicly owned forests, valuable chiefly or partially for watershed protection.

Total Forest	West	East	Whole Country
	(Millions of acres)		
Area partially or wholly for protection	204.6	241.3	448.8
Total of area publicly owned and managed	120.1	10.1	130.2
Percentage public	58.7	4.2	29.2

E. Recreation and Wildlife Conservation. When the national forests were established, providing recreation was not one of the functions ascribed to them. The government had set up its first national parks in outstanding scenic areas before the earliest forests were established, but it did not regard them as recreational areas in the sense the term is used today (Chapt. XVI, Sec. 2*B*). Popular demand has forced both national and state forestry administrations to make increasing provision for recreation both in the management of forests and in their acquisition programs.

Federal and state acquisition of lands exclusively for wildlife conservation is a relatively new departure. Much of the land so taken over is non-forested and therefore does not concern us here. Economic factors and policy questions involved in recreation and wildlife forests and their relation to those set up for other purposes were discussed in Chapter XVI.

F. Sustaining or Restoring Prosperity. This objective is, of course, implicit in most public forest objectives, but earlier forestry thinking tended to lay the emphasis on the prosperity flowing from the use of

[1] This does not necessarily hold for lands bought by large cities for protection of municipal supplies.

[2] Copeland Report, Vol. II, p. 1286, Table 12.

forest products and protective services. Hence they were thought to apply chiefly to consuming regions. More recent thinking, while not neglecting the earlier viewpoints, is much concerned with the local or regional prosperity engendered by such forests in their capacity as producers[1] (Chapt. IX, Secs. 5, 6, and 9). It is not too much to say that some of our better-timbered public forests, managed under multiple-use principles, are the economic mainstay of the communities surrounding them, which are therefore living under permanent forest economies. As time goes on, it is probable that this relation will extend to other communities surrounding national forests.

However, the maintenance or development of regional prosperity by large-scale purchase of lands for national forests has its difficulties. The difficulties arise under two circumstances: (1) purchases in regions where large-scale liquidation of private timber is in progress and the regional economic base will soon disappear; (2) acquisition in cutover and devastated regions where the regional economic base is already gone.

The maintenance of local prosperity in regions in process of liquidation cannot be secured merely by public purchase of the timberland. The operations must be kept going; otherwise the land acquired functions merely as timber reserve (Sec 4*B*), and local prosperity is destroyed immediately instead of at a later date. Nevertheless, the cut must be reduced to put the region on a sustained-yield basis. This problem, difficult at best (Chapt. XV), is complicated further by the fact that the public must expect to have to acquire not only timber but also mills, transport ways, and logging equipment. Buying going businesses instead of just land raises questions of government operation, or at least of government control, of business enterprises not encountered in other types of purchases of forest land. The enormous cost of such a program is an added consideration.

Although its successful carrying out on a large scale might solve many questions as to the future of regions such as the Pacific Northwest and go far toward a stabilization of forest industries of the country as a whole, such a policy has at times been proposed but has never

[1] The turmoil engendered by the reserve policy (Sec. 4*B*) early influenced public forest officials to think in terms of local prosperity (see Secretary Wilson's letter of instructions to Gifford Pinchot in 1905, on the general policy of administration of the national forests when they were taken over by the Department of Agriculture, quoted in Cameron, *op. cit.*, pp. 239–240), but general expansion of the concept did not come till much later, nor did it find much expression in early purchase programs.

received serious consideration.[1] Popular opinion has not been strong in its favor even though it can always be mobilized for acquisition of isolated stands of mature timber in cutover regions (Chapt. XIII, Sec. 8*C*). An active campaign would bring opposition on the score of enormous costs involved and raise the issue of "government in business." Landowners in the regions concerned, who see no other way out of their financial difficulties, might favor it; those prospering certainly would not. The issue may come up actively at some time, but at the moment it seems more likely that solution will be sought by the route of public regulation (Chapt. XXI).

Utilizing public ownership to restore lost forests has been an immediately cheaper and much less thorny political matter and has aroused comparatively little opposition. Nobody wanted the devastated lands and so they either came tumbling back into public ownership by the tax-default route or could be purchased at a fraction of their former value. Counties, states, and the federal government somehow have had to support the stranded forest and agricultural population, for abandonment of submarginal agricultural land added to the problem and in some places created it.

What better solution than to take such lands as public forests and reforest them, utilizing the stranded population to do the work? Thus we have a large and increasing area of public forests in the making. During the development stage they provide some degree of local prosperity (Chapt. IX, Sec. 9*D*), but the communities themselves will not be economically self-sustaining until the new forests are ready to furnish materials and services. The ultimate extension of this land and community salvage program cannot be forecast. It is, however, conceivable that there are lands of such poor growth capacity on which forests would have no indirect value that it would be sound economics simply to let them revert to public ownership, resettle the population elsewhere, and stop there. There is no ultimate public advantage in keeping a community alive at public expense for several generations while it grows a crop it cannot market.

G. Demonstration and Research. Certain states and public institutions, particularly in the East, have set up forests for the purpose of demonstrating forestry methods to private owners. Connecticut pioneered in this development and established such a forest in 1903. Apparently, few landowners were impressed, and the state later embarked on a more extended state forest program along other lines. Example

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[1] Copeland Report, Vol. II, pp. 1151 and 1284.

is perhaps the best form of teaching, but it is not easy for a public body to carry out forestry practices in a manner which a private owner profitably can copy, for it uses different accounting methods (Sec. 5) and is in a totally different position in relation to capital expenditures. Such forests probably have been more successful in familiarizing people with the ideas and techniques of continuous production than in demonstrating methods capable of economic application by the average woodland owner.

Research or experimental forests are often established by educational institutions and forest administrations for the purpose of making fundamental studies of forest phenomena and of discovering and testing different methods of managing forests to attain specific objectives. These experiments may be merely to determine technical points or to work out economic solutions. In any case, what happens to the forest is of less consequence than what is learned from it.

Neither demonstration nor research forests need be of large area but should be so located as to best serve their purposes. It is scarcely to be expected that the two purposes can be served on the same area; each is a separate tool for the accomplishment of different and much larger objectives—the proper handling of forests in general.

H. National Defense. In a military sense, public forests may have two uses in national defense: (1) forests in the interior to be used for military training; (2) forests along frontiers as a screen against attack. During the first World War some public forests were used for training purposes, and in the present war some of the national forests in the South have been turned over to the army for this purpose. A danger of land invasion from Canada might make it wise to nationalize the private forests along this frontier, or at least prohibit clear cutting.

While forests are being used for military training, they are valueless for ordinary forestry purposes. Although defense forests might permit of forestry operations during peace times, the fact that they may be badly damaged makes unwise large investment for timber growing or recreation, and roads built on them primarily must serve military purposes, forestry needs being secondary.

I. As a Public Money-Making Enterprise. The establishment of public forests solely as a business venture is rare. After their establishment and development the objective of operation at a profit may arise. It is discussed in Section 5.

J. Multiple Objectives. It is easy to see that some of the above objectives may be obtained by multiple use of the same areas; others, by their nature, require exclusive use of the forests. Forests of some

kinds are suited to a single major use. However much one talks about it, large amounts of timber cannot be grown economically on some of the forests which have a high protective value or on certain other classes of forest land that probably should be in public ownership. The multiple-use objective should be endorsed wherever applicable as a principle of management, but it will not solve all economic problems which public forests may have to face in the future, particularly if it requires their indefinite expansion (Sec. 8). If the public wants to grow large quantities of timber economically it must choose the right kind of land (Chapt. XIII, Secs. 5 and 6). If it is satisfied to afford protection to steep mountain slopes, it must choose another kind, and so on. If it wants vast woodland parks, it should not choose lands better suited to other forestry purposes (Chapt. XVI, Sec. 2*C*).

5. FINANCIAL PROFITS

This objective implies a policy under which a government goes into the business of raising forest products on a commercial basis, as has been done at times in Europe. It is usually an outgrowth of the timber-production objective (Sec. 4*C*). Although the sale of forest products, timber, forage, water power, and miscellaneous items are common on American public forests, sales policies are not dictated by a financial profit motive. The basis may be a public service one or one dictated simply by a desire to get rid of low-grade products for the good of the forests. Prices are set by competitive bidding or by a desire to move the material or market the service. Any profit which may accrue is welcome but incidental.

Financial profit has never been considered seriously as an objective of public forests in this country although its possibility has often figured in propaganda for their establishment. As they increase in area and salable resources, the profit possibilities as a means to keeping down costs of government may be debated actively. Discussion will revolve around five points. How, for this purpose, is financial profit to be defined? Is it possible under the definition used? Will the public endorse this objective? Is it in the public interest? What effect will it have on the operation of the forests themselves?

Profits may be figured on various bases (Chapt. VIII, Sec. 4). Even when they are determined on the basis of invested capital, many tricky questions of valuation are involved (Chapt. VII, Sec. 7). Profits are particularly difficult to determine in forestry (Chapt. XIV, Sec. 13). Lastly, public and private accounting are usually on dif-

ferent bases. If the concept of profit used in private business[1] is accepted and all the costs of establishing, developing, and protecting our public forests, with their heavy load of non-commercial and denuded land, recreational and protective developments, and administrative overhead, are carried forward at compound interest, a profit on the investment is extremely questionable, except possibly after several rotations or on the assumption that the public forests have a monopoly and the government charges monopoly prices for its timber (p. 438).

Figure 47 shows the approximate relationships between receipts and expenditures of various kinds in connection with the national forests for the past thirty years. Except for their general tendency to increase, they show no consistant relationship, nor should any be expected until capital expenditures for developments (Chapt. XIV, Sec. 4) and land acquisition are completed or stabilized For the first part of the period the forests appeared to have made an operating profit because their receipts from timber sales, grazing fees, and other items exceeded the congressional appropriation for General Expenses. Since then the general expenses have risen above receipts. This is not surprising. In the earlier period the forests were undermanned, did not have a heavy recreational load to carry, did not have the expense of administering large areas of non-productive lands which since have been purchased. As time goes on, the receipts undoubtedly will rise and operating expenses will tend to stabilize. A more or less constant operating profit on costs of administration and protection should then be possible. It is scarcely likely that a profit on invested capital will be realized for a long time for the forests as a whole, though it may be possible to show one on timber sales on the more favorably situated forests if investment and operating costs, not connected with timber-crop growing, are eliminated from the calculations and a low rate of interest is used (Chapt. VI, Sec. 11).

Public reaction to the profit idea is bound up with its conceptions of the proper relations of public and private enterprise. It generally opposes "government going into business," but its attitude toward public ownership of public utilities, particularly in the municipal field, has been pragmatic. There are many public water works, electric light plants, and some local transportation systems. Usually they have been established as the result of unsatisfactory services or charges of local private utilities. Such enterprises are often operated on a service

[1] In public affairs the term profit often means simply an operating profit (Chapt. VIII, Sec. 4).

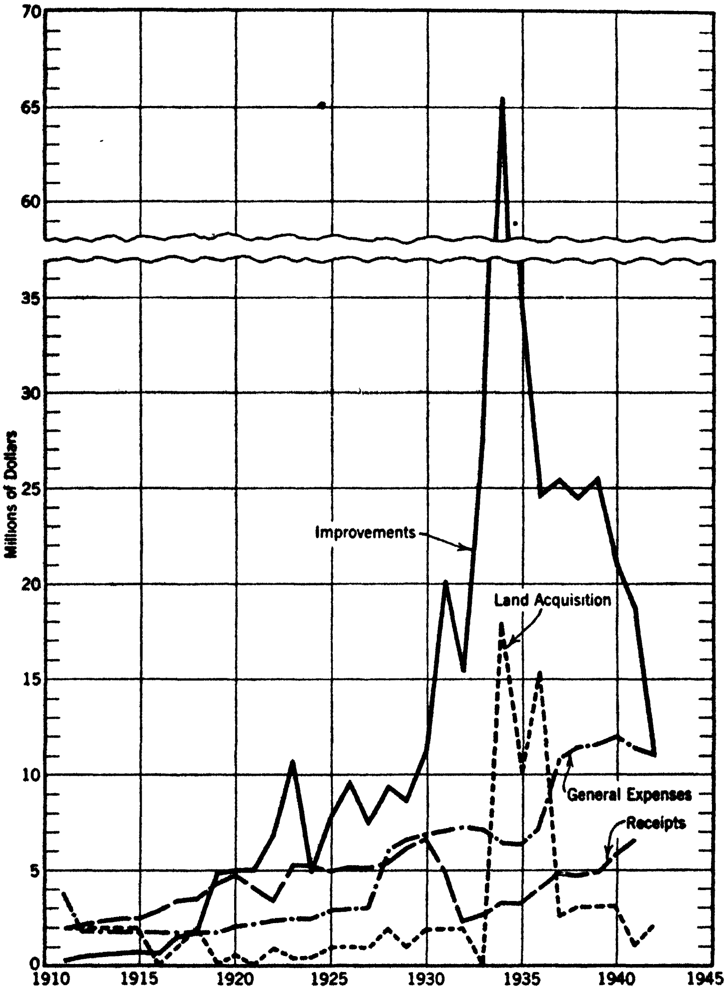

FIG. 47. Approximate annual congressional appropriations for improvement, operation, and land purchase in connection with the national forests, compared with their gross receipts from timber sales, grazing fees, and other sources (1911–1941). The plotted figures are approximations obtained by adding detailed figures, often not easily classifiable under the headings here used. The appropriations themselves do not necessarily correspond to the expenditures in a given year. [Data are from unpublished work sheets kindly supplied by Earle H. Clapp, Acting Chief, United States Forest Service.]

rather than on a profit basis, the public preferring reduced charges to tax decreases.

A public forest is a public utility, but, except for the people in its immediate vicinity, the population is not using its products or services every day or purchasing them directly and, therefore, might prefer to see them operated on a profit instead of a service basis—and pay less taxes in consequence. There is also the possibility of an entire reorientation of public viewpoint on the question of government in business (Chapt. XXI).

The question as to whether a profit[1] basis for public forest operations would be in the public interest hinges on several points. At present it would have only a local bearing because of the small volume of material offered for sale, most of which is consumed locally. An intent to make a profit on its sale would handicap the localities which are often without other local supplies and, indirectly, probably the forests themselves, which are improved by disposition of low-grade material that would not be salable at prices based on production costs. An extension of public forests to a point where the volume of merchantable material was sufficient to be a factor in the national market, or to dominate it, would create problems of relation with private forest owners, discussed in Section 6 and in Chapter XXI, and raise the question: Which will serve the nation best, cheaper products or lower tax rates?

The effect on the forests themselves would depend upon the manner of disposition of the receipts and upon the pressure put on those in charge to show a favorable balance sheet on all transactions. The receipts in whole or part might be turned back to the administration for reinvestment, or for running expenses, with or without added funds from taxation being made available (Chapt. III, Sec. 8*A*). If forest administrations were compelled to use sales receipts to build up stands and install improvements without any public funds, the development of immature stands or even their protection would be a very slow process. If such receipts were added to appropriations, the process would be more rapid. On fully developed forests, operating on sustained-yield basis, the disposition of receipts would be of less consequence.

In any case, great concentration on securing the maximum return from public forests may result in overcutting, underexpenditure for reproduction, endorsement of minimum-length rotation (Chapt. XIV,

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[1] The term profit is used here in the sense of a return on invested capital, not as operating profit.

Sec. 12), and a slow process of deterioration. Lack of any necessity of consideration of costs or profits may result in uneconomic practices, such as over-long rotations and forest manicuring.

6. RELATIONS BETWEEN PUBLIC AND PRIVATE FORESTS

Interaction between public and private forests in the same or even in distant places are bound to occur. These relations may be complementary or conflicting, depending on circumstances and perhaps on points of view. They are complementary if they occupy different classes of land, producing different products and services, as (1) a public protection forest on the upper slopes of a mountain where the timber is not commercial and no attempt is made to market it and (2) private forest lower down where growth conditions are better and forestry is being practiced. They are competitive if they furnish the same sort of products whether they lie side by side or on different sides of a continent—provided the products reach the same market.

The complementary relations can best be brought out by a study of the competitive ones. Competition may exist between buyers, in which case it operates to raise prices; or between sellers, in which case it tends to lower them. When they are engaged in an acquisition program, public agencies are buyers; after land has been purchased and developed, they become sellers of goods and services.

A. Land Buying. Public agencies are only competing with private interests in acquisition programs (Chapt. XIII, Sec. 8) if some one else wants the same land. When land is abandoned for taxes and, since no one will bid it in, it is turned over to a forestry department, competition does not occur even in theory. Millions of acres of state forests have come into being in this way; other millions of cutover and young second growth have been purchased for public forest at prices from a few cents to a few dollars. This shows no evidence of serious competition.[1] Only if public agencies wish to buy heavily timbered lands, desired by private interests for their timber or other purposes, would real competition appear. This policy has never been adopted (Sec. 4*F*).

Purchases of land for public recreational use, particularly in regions where there is an active private demand for it, undoubtedly causes keen competition, in which case, if the public wants the land suffi-

[1] The federal government has purchased, during a long series of years, over 17 million acres of national forest land at an average price of about $3.60 per acre. Report of the Chief of the Forest Service, p. 30, 1940.

ciently, often it must make full use of its financial and legal powers to get it. The same also holds true at times when municipalities are acquiring lands for watershed protection and for occasional parcels of especial interest to private owners in public purchase areas of all kinds (Chapt. XIII, Sec. 8).

On the whole, complaints against programs of forest purchase are more likely to originate with owners who wish to get more for their lands than the public will pay than they are from others who desire to buy these lands. The net effect of such purchases is generally to raise the value of surrounding lands not purchased.

B. Disposal of Products. The sale or other disposition of public timber and other forest products in the market constitutes competition with private industry. Is this competition serious? The annual volume of timber sale of all sorts from the national forests runs about a billion feet board measure, most of it from the West. That from all state and community forests probably does not exceed a few million feet board measure. The following tabulation compares national forest production with that for the nation as a whole.

Year	National Production [1]	National Forest Production [2]	Approximate National Forest Percentage of Production
	(Billions of feet board measure)		
1936	24.355	0.988,304	4.0
1937	25.997	1.491,129	5.0
1938	21.646	1.074,916	5.0
1939	24.975		

1 Source of figures given in Table 14.
2 *Statistical Abstract of the United States*, Table 711, 1939.

Much of this material is low grade and is disposed of locally in sections where the public forests are the only immediate source of supply. Little of it enters national trade channels. It is evident, therefore, that private timber, constituting about 95 percent of total production, does not meet much competition from public sources, nor has it been, except occasionally, particularly objected to by the forest industries. In fact, the public sales are often more complementary than competitive in that they provide stumpage to operators who have

insufficient supplies or none at all, and much of the production is sold in remote sections where private operators cannot market profitably.

The situation may change in the future. Public forests are increasing in area and volume, while private ones in the large lumber regions are being cut out. Whatever the volume ratio of public to private timber may be a generation or two hence, it is reasonable to expect that public percentage will be greater than it is now.[1] The higher it becomes, the greater the potential competition. If it rises to 25 percent, competition would be a factor of some importance; if 50 percent, probably serious; if 75 percent, public timber would more or less dominate the market.

The nature of the competition will depend on public policy, on the one hand, and on private action, on the other. There are infinite possibilities, but it is not likely that this competition will be of the nature that exists among private producers operating today on a liquidation basis. All we can do is to examine a few things which may happen, on the assumption that public forest timber may sometime become a significant factor in national supply.

Public policies as to its disposition may remain as at present—conservative; or they may be oriented toward maximum development of forest product use and marketed in the largest possible quantities in all possible markets; or they may endorse "production for financial profit" (Sec. 5).

The present policy of the Forest Service in selling public timber is a conservative one, based largely on meeting local needs in the vicinity of national forests. The Copeland Report[2] states it as follows:

> The principal objective of timber management on the national forests is to obtain a steady and continuous yield of wood products best suited to the public need. This may be saw logs to be made into lumber for the general market, as in the Pacific Northwest; box shooks for the huge fruit crops of California; hewed or sawed railroad ties of lodgepole pine from the national forests in Wyoming for a transcontinental railroad; mine props for Colorado coal mines; or stulls for a South Dakota gold mine; a turpentine "crop" in Florida; or maple heels for shoe factories in New England. Or, the market being a wholly local one, as that of the ranchers in and near the South Dakota portion of the Custer National Forest, where the local timber supply is so limited and the local demand so great that every

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[1] In 1933 the Copeland Report, Vol. I, p. 579, estimated the total saw timber on the national forests at 552 billion ft. b.m. as compared with a national total of 1667.8 billion ft. b.m.

Volume of commercial timber on state and local public forests is very small.

[2] Vol. I, p. 580.

tree is zealously fostered until ready for cutting. A controlling principle in the disposal of national forest timber is first to provide for the local need, if dependent on the national forests, before supplying more distant markets.

This policy does not influence the price structure of the forest industries. No attempt is made to force timber on the market in direct competition with active private operators who own their stumpage, although operators who do not own their stumpage or who have an insufficient supply or wish to conserve it may buy government stumpage on the basis of competitive bids (for all except the smallest sales) and under forestry restrictions that increase operating costs over the liquidation operations customary on private land. The government neither operates its own mills nor does its own logging although it makes some of its own cultural cuttings. Competition is therefore restricted to the supplying of raw material. Because some of the forests contain unexploited mature stands, they still function somewhat as timber reserves.[1]

These policies, continued in the face of an increasing supply of public stumpage, might lead to the revival of timber-reserve concepts with unfavorable effects on local economies (Sec. 4*B*), on the one hand, and might raise prices of forest products from presumably declining private production, on the other hand, resulting in unfavorable national effects. Operators having stumpage of their own could scarcely complain of government competition, but those wishing to purchase public timber might object to lack of cooperation on the part of government.

A policy of marketing public timber in the largest possible volume to promote general consumption on an "economy-of-abundance" philosophy (Chapt. VIII, Sec. 5) would certainly provide severe competition for private industry, which only the favorably situated units could meet, and might well result in abandonment of all attempts at private forestry.

If the public forests attempted to operate on a full-profit basis (Sec. 6), the government would have a stake in keeping prices high and private operators would have less to complain of, but very high prices might well restrict consumption (Chapt. XII, Secs. 2, 6, and 7).

Any comparison of production costs of public and private timber is difficult because of the great variation of conditions and methods of

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[1] State policies are largely limited perforce to sales of inferior materials removed in cultural operations (p. 286). Stumpage sales, contract cutting, and removal by state-employed labor are all used.

accounting involved. If the present relation holds—namely, that private forests are situated on the best land but have to produce at a profit—while public forests on poorer land can produce with some disregard to profit motive, one advantage might offset the other, or it might not. In any event the general factors likely to regulate prices in the future when virgin, natural second-growth, and forestry-grown timber must also be considered were discussed in Chapter XII, Section 6. Possibilities of government control of private forests and of forest products prices which may also affect future relations, are taken up in Chapter XXI.

7. RELATIONSHIPS BETWEEN PUBLIC FORESTS MANAGED BY DIFFERENT AGENCIES

The division of public forests in the United States into national, state, and local, and sometimes a division of management between different agencies within the same governmental units, corresponds to the American political set-up. Divisions of the first kind are political and territorial; those of the second, administrative or functional.

The proper relationship and relative effectiveness of these divisions have been much discussed. Effective organization must take account of both the theoretical and the practical aspects of the problems encountered in acquiring and managing public forests to get their maximum social and economic benefits. To this end, practical considerations may often outweigh theoretical ones. Perhaps the best way is to examine the actual working out of the problem in practice; first, as to political units; second, as to its administrative bodies.

A. Political Divisions. The original western national forests were national forests because the land on which they stood belonged to the federal government which, Congress and the public being willing, could handle its property as it saw fit. The issue of turning them over to the states to manage as state forests, under the doctrine of states rights, was raised only by those who did not want them managed as public forests at all and hoped that the states would not succeed in so doing.

In the East, the federal government was not an extensive landowner. The pressing forest problem was the protection of the headwaters of important streams. Only in the case of the Hudson River could this be solved by the action of a single state. Elsewhere this problem was regional, and arbitrary state boundaries inhibited a regional solution. Theoretically, states can work out solutions of regional problems by agreement, but this has never been done on a

large scale. Therefore, the federal government took over the acquisition of forests on the Appalachian and White Mountain watersheds, by act of Congress and consent of the legislatures of the states involved.

State forest problems were first faced in the East where the states were strong financially and administratively, and it happened that the pioneers in state forest development, namely, New York, Pennsylvania, and Connecticut, were states where the problems were chiefly of state rather than of regional or national concern. Wherever this is not the case, the failure of a state to act and its refusal to allow the federal government to act prevent anything from being done, whether the problems are federal, regional, or local. Failure of states to act may be caused by financial inability, adherence to ideas of states rights, or lack of popular understanding.

State attitudes toward federal acquisition of forests within their borders seem to fall into four general patterns: (1) not wanting federally owned forests within their borders, but engaged in building up state systems more or less successfully; (2) not wanting national forests, but doing nothing about any of their own; (3) welcoming federal acquisition for major areas and attempting to build up state forests for the solution of state problems; (4) expecting the federal government to do the whole job.

With the present tendency of most states to cast more and more of their problems on the federal government, whether they are capable of solving them or not and with the apparent willingness of the government to assume these burdens, the question is increasingly important on how far the federal government should go in creating public forests on relatively small areas (which are largely of local significance and, theoretically, should be state forests). It is complicated by the fact that, even among the states wishing to develop their own forests, some may be financially unable to do so.

There are both theoretical and practical objections to too much federal assumption of responsibility. The setting up of a huge federal bureaucracy to handle local problems has an adverse effect on local initiative. Granted equally high administrative standards, the states should be better qualified to administer efficiently forests ranging from 10,000 to 100,000 acres (the approximate size range of most state forests) than the federal government, geared to manage forests of very much larger area. The financial difficulties that many states encounter in buying state forest land may be overcome by federal assistance in the form of gifts or long-term leases (Sec. 8).

The theoretical and practical relationships between state and community forests resemble those between national and state forests although their evolution has been somewhat different for the following reasons: (1) States exercise a greater sovereignty over their constituent units than the federal government does over the states. (2) Communities generally have realized a need for ownership or control of forest land sooner than have the states. Many municipalities early found they needed to control forest land to protect their public water supplies, or have wanted to have them for park use. To accomplish these ends they have often had to go outside their own boundaries for land. The states, confronted with the choice of administering forests for municipalities or authorizing them to purchase the necessary lands in other communities, have generally chosen the latter course. So we have what are, in effect, local or regional forests for both purposes, established by state permission but not with state aid (Sec. 2*D*).

State forests have been acquired to cover larger areas and with more generalized objectives. Recently, the appearance of the rural or county community forest, administered for general forestry purposes, has brought up problems resembling those between states and the federal government. Theoretically, which is better: local or state ownership and administration of these areas which individually are usually rather small? On this point there are two schools of thought. One holds that, since they can be set up in small units and the results of popular effort readily are seen by the public that owns them, they should be encouraged. The other believes that local management without means or inclination to hire technical assistance is bound to be inefficient. Therefore, if they are to be widely extended in area and number, definite state supervision and financial assistance are essential and they should be units in a state system.

As in state and federal problems, the solution will be worked out in terms of who has the money and the will to do the job. Probably no two states will arrive at quite the same solution.

B. Administrative Divisions. The division of administrative control over public forests may take any of three forms: (1) Different departments may manage different forests for the same objectives. (2) Different departments may manage different forests for different objectives. (3) Different departments may manage different aspects of business on the same forest.

There is no logic and every practical disadvantage in the first form of division. The setting up of a separate administration to handle the remaining forests on the public domain, which are usually adja-

cent to national forests and have the same general objectives, is as illogical as establishing a new fire department in a city every time a new ward is created.

Forests managed by different agencies if they are used for different purposes has a logical basis if the purposes are exclusive, specialized, and a subordinate part of some other enterprise. The forest surrounding a city reservoir is primarily to protect the water supply; the business of the water board is to provide pure water to the city. The city parks also contain woodland, but it is only a part of the park commission's responsibilities; its business is to supply recreation in a large variety of forms. To give either commission authority over all woodland would be absurd. To organize a forestry department to take over management of woodland on both would be to break up the logical organization of two separate businesses. No doubt both forests should have technical supervision of foresters, and if the areas are small both could be served by one forester if the city could not afford two.

In large forests, where the objective is to promote the best possible use of all forest resources for the public as a whole and for local, regional, and national ends, one encounters the multiple-use versus single-use concepts (Chapt. IX, Sec. 5*D*, Chapt. XVI, Sec. 4, and Sec. 4*J* this chapter).

The third form of overlapping administration is that by which different departments manage different resources and activities; thus one handles timber; another, recreation; a third, wildlife, and a fourth builds roads, telephones, and fire lines. While this recognizes multiple use, it does not coordinate it or settle the question of major and minor uses. Each department tends to magnify its own functions; squabbles are inevitable. If one department finally dominates, the result may be single use even though the function it represents is not the most important. Compromise in forests so administered often ends in dividing them into a patchwork of single-use areas without any logical basis and a heavy overhead for uncoordinated administrations of different resources and services.

The best form of administration for large public forests is one in which they are administered as a whole to obtain the maximum possibilities from all resources—just as a farmer manages his farm.

8. THE FUTURE OF PUBLIC FORESTS

The public forest area is increasing and practically everyone admits that further enlargement is desirable, but there is no agreement as to

the ultimate size, nature, and location of the additions, or as to distribution between national, state, and local ownership. Proposals range all the way from complete nationalization of practically all forest lands to those which call merely for rounding out existing boundaries and eliminating interior holdings of the present forests. These divergences are explainable because they are based on opinions concerning future needs or are the outgrowths of political philosophies.

An optimistic outlook on probabilities of wide extension of private forestry would lay emphasis on acquisitions largely for protective forests on non-commercial forest lands—hard as that is to define for all times and purposes. A pessimistic view would incline to lay more emphasis on public acquisition of commercial lands. A trend of thinking which favors enlarged scope of public activity in economic affairs would favor greater extension than a cast of mind opposed to such increased activities.

In any event the ultimate extension of public forests will depend upon many factors, among the most important of which are: the extent to which private forestry is practiced—either voluntarily, with or without public assistance, or by compulsion under public regulation (Chapt. XXI); the amount of public money available for land acquisition (this being related to the general economic prosperity), popular attitudes toward expansion of government activities, and continued success of management of forests already in public hands.

From time to time, national and state and regional agencies have worked up public forest acquisition plans, usually specifying immediate and ultimate objectives. The immediate objectives were the more realistic and have served a concrete purpose of guiding programs in accordance with most pressing needs and current possibilities. The ultimate objectives have not mattered as much, whether sound or not. The long periods required to attain them, even under the best of circumstances, are a guarantee that they can be modified as necessary. Such plans usually have been developed as parts of more general ones for development of all phases of forestry or for the place of forests in land use and they have frequently considered public regulation of private forests. None of them has proposed that the major portion of the country's forests be taken over by the public.[1]

[1] The more important of these national plans are:

Report of the National Conservation Commission, Senate Document 676, 60th Congress, 2d Session, 1909.

Report on Senate Resolution 311, *Timber Depletion, Lumber Prices, Lumber*

Considering the rather slow and somewhat spotty growth of public forests in the past and the present trend of thinking which apparently favors attempting further measures of assistance and control of private forests, it does not seem likely that extension of public forests will proceed at a rate fast enough to make public ownership the dominant American form in the forseeable future. A breakdown of all prospects of private forestry with or without public assistance or regulation might greatly accelerate the rate of public acquisition.

Exports and Concentration of Timber Ownership, 1920. (Commonly called the Capper Report.)

A National Plan for American Forestry. Senate Document 12, 73d Congress, 1st Session, 1933. (Commonly called the Copeland Report.)

The Forest Lands of the United States, Report of the Joint Committee on Forestry, Senate Document 32, 77th Congress, 1st Session, 1941. (Commonly called the Bankhead Report.)

All were published by the Government Printing Office, Washington, D. C.

CHAPTER XXI

PUBLIC ASSISTANCE AND REGULATION OF PRIVATE FORESTS

✓Despite the assistance given by the public, private owners have been so slow to undertake forestry that the question of public compulsion, with or without further assistance, is being more and more agitated. Public controls over all kinds of private enterprise and property are constantly increasing in number and scope. In considering public regulation of forests it is necessary to understand the general controls exercised over other enterprises as well as the specific nature and special problems of forest controls.[1]

1. THE LEGAL ASPECTS

The inherent powers of government to control the use of land were outlined in Chapter XIII, Section 3. These same powers apply to all phases of economic activity. They may be exercised through the so-called *police power* under which a government can require everyone to do what it deems necessary to public welfare, as governments of countries at war require their citizens to obey blackout regulations; or they may be applied through special laws such as zoning or sanitary ordinances (Chapt. IX, Sec. 7). Governments also have the power to assist private business when it appears to be to the public interest, as the United States government has recently assisted agriculture in order to keep farms in production when prices for farm products were too low to yield a profit. They may also control private industry, as when they regulate wages and hours of employees.

✓These powers may be direct or indirect, general or specific, coordinated or uncoordinated. Legislation may favor a certain type of activity or give it specific aid: one set of our maritime laws forbids foreign ships to carry passengers or freight between American ports; other laws subsidize shipping in various ways. Regulation can be

[1] For references to public assistance to private forestry and public regulation of private forests see A. Z. Nelson, *A Selected Bibliography on the Economics of Forestry in the United States*, pp. 29–35, United States Forest Service, Washington, D. C., 1941.

negative, as it is in zoning laws which specify how property may not be used; that is, a filling station may not be built in a residential section. Or they may be positive, stating how certain activities must be conducted, as when a city grants a franchise to a bus line it usually specifies the route over which its busses must travel and how many must be kept in operation. The same powers may be used at different times and places to assist, regulate, or discourage an enterprise. This is especially true of the power of taxation (Chapt. XVII, Sec. 1). Government may even exercise its powers in opposite directions at the same time, as it does when it makes expenditures for forestry research aid private owners, but passes unwise forest taxation laws that work against them. Both assistance and regulation may be provided for in the same law. For example, forest fire laws assist the owner in protecting his property and at the same time may regulate his activities in brush burning.

The passage of laws to assist or regulate the conduct of business and the use of land is sometimes hampered—even when the proposed laws meet popular approval—by constitutional limitations, the repeal of which is a complicated and time-consuming process.

The tri-partite nature of the American setup, with powers both divided and overlapping between federal, state, and local bodies, frequently leads to uncoordinated application of both assistance and regulation, and to questions of jurisdiction. The resulting conflicts do not operate either in the interest of the public or of the activity involved.

2. ECONOMIC ASPECTS

In its broadest aspects, public assistance is expressed in such laws as those regarding theft, arson, and unfair competition, the supposition being that, given such elementary legal protection, individuals and enterprises can take care of themselves. When an enterprise would be of special value to the public but cannot establish or perpetuate itself because of economic handicaps, special assistance may be granted. Supposedly this assistance does no more than offset the handicap so that both owners and public may profit. Aid may take many forms from technical advice to protective tariffs or loans not obtainable from private sources, or even to direct subsidies (Chapt. II, Sec. 4).

Theoretically, once this handicap has been overcome, the assistance is withdrawn and the enterprise stands on its own feet. Occasionally an industry continues in its privileged position because of public inertia or political pressure, then it may make an unjustifiable profit at public expense. It is sometimes said that protective tariffs, which

were indirect subsidies to early American industry, have remained in effect to the great profit of the industries and loss of the public.

Regulation of the use of land or the conduct of industry is usually set up to prevent damage or loss to the public. It may apply to land or industry as a whole, to a broad class of each, or to a particular industry. It may be total or partial. Thus the use of forest land may be regulated but not that of farm land. The working conditions in all industries may be regulated, but the standards of production may be defined only in those where the public would suffer from substandard products, as the foods and drug industries.

Regulation in America has not attempted to embrace all aspects of business and has generally been of a negative character, that is, it has stated what may not be done, but it frequently happens that different aspects of a particular business are regulated by different government departments or some aspects of the business may come under federal and some state control. The resulting confusion has not been favorable either to the business or to the public.

Regulation must have a definite objective. Should railroads be regulated with the objective of cheap rates, or to maintain a system of public transportation on an economic basis by curbing bad financial and technical practices, on the part of the railroads, which tend to wreck their solvency and efficiency? Whatever its objective, regulation costs the owner money. The more intensive it is, the more it costs. The owner may try to pass the costs on to the consumer, but if they are too high the public will not pay, or, since control may include price fixing, perhaps the cost cannot be passed on. In either event, both the owner who wants the profit and the consumer who needs the product find themselves in a difficult position. The solution seems to be for the government to abandon regulation, to sustain a high price structure or assist the industry by showing it how to operate more cheaply, or to subsidize it.

The remaining sections of this chapter present a discussion of public assistance to forest owners and public regulation of forests, based on the preceding material.

3. PUBLIC AID TO PRIVATE FORESTRY

Chapter II, Section 4, lists some of the forms of assistance that national, state, and local governments have given to private forest owners. Other kinds are mentioned below. All have been given with the idea of affording help to an enterprise which could or would not be carried on without public aid. Some of it has been general, such as

the dissemination of technical information; some has been specific, amounting to a subsidy, as the paying of bounties to a farmer under the Agricultural Adjustment Act, or the disposal of forest planting stock free or at cost. Some assistance has been class legislation in that it applied only to one group, generally farmers. Aid in fire protection sometimes has regulatory provisions as well. Aid in the form of workable systems of taxation was discussed in Chapter XVII, Sections 7 and 8. Some specific aids have had a contractual form, as when an owner receives planting stock from the state nursery he must agree to plant it in a certain way and to care for it for a certain length of time. Sometimes it is in the shape of a bounty paid for something done to establish or improve a forest but with no promises to continue the work.

It would be foolish to deny that these aids have produced good results and still more so to assert that they have solved the problems of private forestry. Assistance has been sporadic; the owner generally has been free to accept or reject it. When it has been mandatory, as fire laws, the help they have given has been negative. Nowhere have they operated under a systematic plan to meet the needs of either owners or public. The failure to enact workable forest tax laws has left one of the basic problems of the private owner untouched, even where taxes are not a present burden (Chapt. XVII, Sec. 5*B*). Nothing important has been done to help the owner in what is often the most pressing problem—financing long-term operations. It has often been proposed that the government make long-term loans of low interest rate under contractual provisions to protect public interest and finance private forestry. They may be the next step, but success might call for other forms of aid and perhaps also for regulation.

It is evident from past experience that, if public assistance is to be depended upon exclusively to solve the problem of private forestry, it must be expanded in amount and scope and coordinated in approach. In doing this, it must be kept in mind that (1) the owner is under no compulsion to accept it, nor will it necessarily be accepted by owners in those regions where the development of private forestry is most essential for the public good. (2) Since the more aid offered, the larger the number of owners who will probably take it, the public may have to raise the amount continually in order to get enough owners to meet public needs. Under these circumstances the public, sooner or later, would be paying an unreasonable price and the owners would be getting a subsidy out of proportion to their efforts. This does not imply that increased aid may not be justified, but it points to the fact that regulation may be necessary to supplement it.

4. THE NATURE OF PUBLIC CONTROL OVER PRIVATE FORESTS

Since public regulation is highly controversial as well as very intricate, an outline of its historical background may be helpful. Public interest in forests and their products has existed from time immemorial, and their control has long been a government function. In Europe this control goes back at least to the early Middle Ages, and it has not been unknown in America. Its form has varied with the economic, social, and political structure of societies and their needs. The economic or political group in control of a government has appropriated, distributed, or managed the forests and their products as it saw fit. When it represented large landholders, they secured the economic benefits; when it represented all the people, the economic rewards were more equitably distributed. When government was strong, control was strict; when it was weak, it was lax. When it had interests of its own, it provided the necessary control to realize them.

The earliest forest control was over wildlife resources. In the Middle Ages wildlife was almost as important a resource as in pioneer America. Under the feudal hierarchy it was graded into king's, noble's, and commoner's beasts and birds, regardless of who owned the land on which they lived—and the commoner's beasts and birds had little food or fur value. As central governments arose, they were dominated by a landholding aristocracy and game became the property of the landholders. Later, as certain governments became democratic, game became public property, as it soon did in America where everyone had the right to hunt. Increasing scarcity led to public restrictions, as to hunting seasons and bag limits, on the theory that if the game was public property the public had the right to control it.

The medieval struggle between lords and peasants over the use of grazing and timber on land of doubtful or divided ownership made it necessary for governments to regulate the use of these products between man and man and then set up controls to keep the forests productive. The early breaking down of the attempt to introduce these controls into colonial America was described in Chapter XI, Section 1. Thereafter for nearly a century the only control was the rather ineffectual attempt of federal and state governments to prevent forests on public land from degenerating into vast public commons from which any citizen might cut as much timber as he wished and in any way he chose.

The major effect of the early conservation movement was to build up a great system of public forests without any restrictions on private owners (Chapt. XX, Sec. 2). At the same time certain state forestry

laws were enacted on the principle that the public had an interest in private forests and, in order to protect this right, could curb somewhat the activity of owners. Forest fire protection laws are a clear expression of the public interest in forests. Laws which regulate the times when brush may be burned and require a permit to do it; laws regarding the disposal of logging slash so as to minimize fire hazard are regulatory in intent. The same is true of laws permitting public agents to enter private forests and to cut trees or brush in order to check the spread of harmful forest insects and fungous diseases. Such controls are now fairly well established in most states and receive the general approval of both public and owners. A few states have gone somewhat further and have applied land zoning (Chapt. IX, Sec. 7) to forests, largely to prevent their being used for uneconomic agriculture.

But these negative controls neither keep forests continually productive nor specifically limit a proprietor in his cutting practices. However, they are not a specific financial burden on the owner because most of the cost is met by general taxation. What may be called *management control* or *public regulation of private forest management* tells the owner how he shall cut his timber so that there may be a continuous supply for the common welfare. The remainder of this chapter is concerned largely with this type of control and is referred to simply as *regulation*.[1]

5. IS REGULATION NECESSARY?

At present we have too few facts to work on and, in dealing with those we have, the thinking of even the expert is likely to be colored by his conception of the proper relationship between the individual and the state. This makes it difficult for him to think objectively about what facts there are.

Are our forests, over the nation as a whole, growing faster than they are being cut? If so, is regulation needed? Or is the annual growth less than the annual cut, and is regulation imperative? We do not know the facts on which to base a conclusion and cannot until we have a complete forest inventory of the United States, not only for the country as a whole but also by forest regions and states, kept up to date by frequent comparison of growth and cut.[2]

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[1] Used in this way, the term should not be confused with the term as used in a highly technical sense in forest management.

[2] Some years ago such a forest survey was started, but it has never been completed and is now progressing very slowly.

Whatever such a comparison for the nation as a whole might show, the United States cannot be treated as a single working circle (Chapt. XV, Sec. 2). Overcutting in one region might be balanced by growth in another in cubic feet but not in economic value. Different regions produce different products and feed different markets. Good forestry in one region does nothing to prevent erosion and floods in another. With all the facts available it would probably appear that some form of regulation is necessary, or at least desirable in some places, another kind or intensity in others, and none at all in still others. The advocates of regulation can argue that national regulation is therefore required in forms varying from severe to nominal, to meet the needs of different circumstances. Its opponents might say that if private initiative has solved the problem in some regions it should be able to do so everywhere.

The groups most immediately concerned and most familiar with the problem are the forestry profession and forest industries, and each has declared itself. The Society of American Foresters has endorsed regulation in principle.[1] The National Lumber Manufacturers Association,[2] representing the forest industries as their most important organization, has made a somewhat qualified but nevertheless significant statement: "We believe that the establishment of forestry practices suited to continuous forest production is an obligation of forest owners and of the industries using forest products. . . . Such regulation as may be necessary or desirable should, we think, be applied and administered under State Law. . . ."[2] Whether even this qualified endorsement would be accepted by the majority of forest owners is questionable.

Among those favoring regulation there is great divergence of opinion as to its form and intensity and as to what public agency should do the regulating. Since there is already a certain measure of public control over private forests (Sec. 4) and the tools are at hand for its extension, debate is more and more turning to methods and specific objectives rather than to its desirability. The question will finally be decided by public opinion as expressed in national and state legislative bodies. Foresters, forest industries, and forest landholders can and should aid in the establishment of sound policies but cannot hope to dictate them.

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1 "Statement of the Council of the Society of American Foresters on Regulation of Private Forest Management," *S.A.F. Affairs*, Vol. 7, No. 4, p. 34, April, 1941.

2 H. Collingwood, The Forestry Omnibus Bill, p. IX, National Lumber Manufacturers Association, 1337 Connecticut Avenue, Washington, D. C., 1941.

6. PROBLEMS OF PUBLIC REGULATION

It is easy to draw up bills for the public regulation of private forests, stating that they are to be managed for continuous production, so that the public will have a perpetual timber supply, soil will be protected from erosion, wildlife will be conserved, and regional prosperity will be maintained. The applications of such laws in the woods must raise many questions of emphasis and degree, and as many more about methods of operation. Not all forests are equally useful for all purposes, and at times the purposes may be mutually inconsistent (Chapts. IX and XVI). The resulting problems, so far as the public is concerned, are very similar to those discussed in Chapter XX, Section 4, for public forests.

The term "continuously productive" also needs definition. Does it mean that the owner is required to make cuttings only in such a way that reproduction will follow, or does it mean sustained yield (Chapt. XV, Sec. 1)? There is a vast difference. The first requires only a slight modification of ordinary cutting practices, such as leaving seed trees and protecting young growth, and in some cases, no modification at all, as in hardwood stands of species that sprout freely, but it does not prevent liquidation in the sense of cutting all or practically all the merchantable timber at one time. If this is done by all the owners in a region, it will be many years before there will be another crop of trees. Under these conditions regional prosperity suffers as much as if the forest had been completely destroyed except that some day it may be expected to return. If "continuously productive" implies keeping forest industries going in a given region, it must mean sustained yield for that region, even if not for the individual owner (Chapt. XV, Sec. 2), and the problem becomes exceedingly complex. At present "continuously productive" is usually interpreted as meaning cutting in such a way as not to cause complete forest destruction. Sooner or later such an interpretation may be questioned and, regardless of interpretation, attempts made to regulate on sustained-yield principles.

No law can do more than set general objectives although greater precision than has been attained in laws so far proposed would seem possible. Nor can a law specify, even in general terms, methods of cutting necessary to attain them. Silviculture is too difficult an art to be successfully embalmed in lawbooks or administrative regulations. Much discretion must be left to regulatory bodies in applying standards in the field that are both silviculturally sound and at the same time economically feasible for the landowner (Sec. 8).

Any direct form of regulation is influenced by other laws applying to property in general or to the property being regulated. The inconsistency of regulating forests, on the one hand, and taxing them according to a bad system, on the other, has been mentioned. A problem perhaps equally serious may arise if the public powers to control prices are expanded and continued indefinitely. A public price-fixing policy may have for its objective either low prices for the benefit of consumers or high ones to encourage the producer. Any form of forest regulation that does not consider these factors as they apply to owners and public may involve both in serious difficulties. Since regulation must cost the owner money (Sec. 8), he will want to raise prices; if he raises them too high, consumption declines and both he and the public suffer.

One of the outstanding questions as to regulation is: Who is to do it, federal, state, or local government? Another is: Can it be enforced? The following sections consider these questions.

7. FEDERAL, STATE, OR LOCAL REGULATION?

Direct regulation is possible by any of these units [1] but the indirect tools are divided between the federal and state governments. Since local units can act only in a small sphere and under state supervision, the real issue is between federal or state control or some form of combined control.

Those favoring state regulation point to the facts that the state is closer to the problems of the landowner, and has direct control of land through taxation and zoning powers, and that each state has different problems needing different kinds and degrees of regulation. Those favoring federal control say that, since the problem is national in scope, it should be handled on a national scale and that the federal machinery can be made flexible enough to handle local problems in accord with local needs. They also point out that not all states have forestry departments adequate to the job and regulation by states must therefore come slowly if at all. They do not face the fact that Uncle Sam has no power of zoning or local taxation. Yet, if they wished, they might reply that the power of the purse is very great, and the enormous financial powers of the federal government could probably be used to force states to comply with its wishes and not tax forests

[1] The federal government has no direct power over land use, but it can exercise direct regulation by indirect means through its power to control interstate commerce. This is invoked in various regulatory bills before Congress (December, 1941).

in an arbitrary way. Although the federal government has no control over state policies of forest taxation, it probably could force states, by giving or withholding grants, to conform more or less to its regulatory policies.

8. REGULATION AND THE OWNER

The owner's reaction to regulation will depend upon how much it affects his operations and how much it costs him, which in turn would depend upon its form and intensity. If it only required some provision for reproduction when his stand was cut, thousands of owners would be touched by it only when millions of acres of immature trees became merchantable, perhaps fifty years hence. The only ones immediately concerned are those having mature timber which they wish to liquidate. If the forest to be cut contains a sufficient volume of young growth, scattered throughout to serve as the basis of a later crop, it will only cost what is necessary to control logging damage to this young growth. If the forest is mature, it will cost the realization value of the timber he must leave to secure reproduction. It may be argued in both cases that it really costs him nothing because he or his heirs will get it back at compound interest when the new crop matures. If he cannot afford to make the investment now, or is not interested in the welfare of his heirs, the argument will leave him cold.

In its own interest, the public may turn a deaf ear to these landholders, just as it does to owners who complain about having to install septic tanks or fire escapes, but, if regulation approaches the point where the expenses become so great that the owner cannot operate his property profitably, he must sell it for what it will bring or abandon it as operators often abandon cutover lands. This might be a way to increase the size of public forests, but hardly one fair to a large class of property owners.

An attempt to force sustained-yield forestry on owners, particularly those whose holdings are not well suited to it, or who are in serious financial difficulties, might have this effect. It is not probable that measures merely to insure reproduction would do this. Another situation in which owners might be placed at a serious financial disadvantage is one in which they wish to put their forests to other uses. If the land is suited to agriculture, should the owner be prevented from so using it, unless there is some special reason why it is in the public interest to keep it in forest? If it is not really suited to agriculture, the public may be doing the owner a real service in making him keep it in forest.

It is probable that many forest owners most concerned with regulation, namely, operating lumbermen, are more disturbed about how it would affect their logging costs and how much timber they would have to leave standing than they are with the abstractions of the case. They are willing to acknowledge their responsibility as owners to keep their property productive but believe they can and should do so without public regulation. They doubtless believe also that they can do so more cheaply themselves than under the direction of publicly employed foresters, who are more familiar with the technical than the financial aspects of forestry. Although it is a matter of public policy whether or not they should be given the opportunity to demonstrate their ability, it is certain that their point of view must receive consideration if regulation is to succeed. Applied arbitrarily by men not solidly grounded in both silviculture and economics, it will certainly fail.

Whatever form of regulation may be attempted, some owners will fight it. This fight will follow the now-familiar pattern—challenge the law's constitutionality; appeal to courts against administrative rulings; attempt to hamper administrative agencies by working for reductions in their appropriations and by securing appointees likely to look the other way at the right moment; and, finally, outright disregard or evasion in the woods.

Since forest laws and regulations are always difficult to enforce, and, more especially, those concerning the difficult art of silviculture, management, regulation, would be extremely easy to evade by either ignorance or intent. Regulation without good will, plus a lot of education of landowners, might fail in the woods even if it stood up in the courts and administrative agencies. If the regulation were exceedingly restrictive, it might go the way of the late "prohibition experiment" and set back all phases of the forestry movement for a generation.

9. A COORDINATED PROGRAM FOR REGULATION AND ASSISTANCE

Any program of forest regulation, to succeed, whether on a national or a state basis, must recognize that some forests, chiefly small ones perhaps, have no public significance, and the owners should be free to treat them as they see fit; certain areas, not necessarily in forest, ought to be; certain others are valuable chiefly for protection purposes (the maintenance of almost any sort of forest is sufficient to accomplish this); still others, because they are capable of producing valuable timber, demand attention to bring and keep them to high-produc-

ing capacity. In other words, forests should be zoned (Chapt. IX, Sec. 7), and regulation should be adjusted to the needs of the zones. Since regulation is new and complicated, it should be started with minimum and flexible provisions, capable of being changed as necessary. Little should be expected beyond the assurance that reproduction will follow cutting. The viewpoint of the landholders should be considered by setting up machinery through which it can be expressed. Some assistance through tax adjustments, fire protection, and possibly forest insurance as is needed, should be afforded. If price controls of forest products are to be a permanent feature of American economy, they should be so adjusted as to keep prices at a level not too high to discourage consumption nor so low as to discourage production. If, as time goes on and it develops that further regulation is desirable to stabilize production on a sustained-yield basis, it will probably be necessary for the government to go into a sort of partnership, voluntary or otherwise, with owners, to provide them with long-term credit facilities at low interest rates, and arrange for the pooling of cuts and the allotment of returns on a cooperative basis (Chapt. XV, Sec. 2). Such development may never come to pass, perhaps never may be needed, but it would be the final expression of public regulation short of complete public ownership.

APPENDIX[1]

COMPOUND INTEREST TABLES

Column 1 *Compound Interest*—The value of \$1.00 at n years

$$V_n = V_0(1.0p^n) \quad \text{when} \quad V_0 = \$1.00 \quad \text{(p. 84)} \quad [\textit{Formula 2}]$$

Column 2 *Compound Discount*—The present or discounted value of \$1.00 for n years

$$V_0 = \frac{V_n}{1.0p^n} \quad \text{when} \quad V_n = \$1.00 \quad \text{(p. 86)} \quad [\textit{Formula 5}]$$

Column 3 *The Value of an Annuity* of \$1.00 for n years

$$V_n = \frac{AR(1.0p^n - 1)}{0.0p} \quad \text{when} \quad AR = \$1.00 \quad \text{(p. 88)} \quad [\textit{Formula 6}]$$

Column 4 *The Present or Discounted Value of an Annuity* of \$1.00 for n years

$$V_0 = AR\frac{(1.0p^n - 1)}{0.0p \times 1.0p^n} \quad \text{when} \quad AR = \$1.00 \quad \text{(p. 89)} \quad [\textit{Formula 7}]$$

Notes: All figures in Columns 2, 3, and 4 may be derived from Column 1 by inserting them in the appropriate formula and solving for \$1.00. Tables giving values $1.0p^n$ only in tenths of percents are found in Chapman, *Forest Finance*, and in Mathews, *Management of American Forests.*

[1] These tables have been adapted with minor changes from H. H. Chapman, *Forest Valuation*, John Wiley and Sons, New York, 1915.

$\frac{1}{2}$ PERCENT

n Years	1	2	3	4
1	1.0050	.9950	1.0000	.9950
2	1.0100	.9901	2.0050	1.9851
3	1.0151	.9851	3.0150	2.9702
4	1.0202	.9802	4.0301	3.9505
5	1.0253	.9754	5.0503	4.9259
6	1.0304	.9705	6.0755	5.8964
7	1.0355	.9657	7.1059	6.8621
8	1.0407	.9609	8.1414	7.8230
9	1.0459	.9561	9.1821	8.7791
10	1.0511	.9513	10.2280	9.7304
11	1.0564	.9466	11.2792	10.6770
12	1.0617	.9419	12.3356	11.6189
13	1.0670	.9372	13.3972	12.5562
14	1.0723	.9326	14.4642	13.4887
15	1.0777	.9279	15.5365	14.4166
16	1.0831	.9233	16.6142	15.3399
17	1.0885	.9187	17.6973	16.2586
18	1.0939	.9141	18.7858	17.1728
19	1.0994	.9096	19.8797	18.0824
20	1.1049	.9051	20.9791	18.9874
21	1.1104	.9006	22.0840	19.8880
22	1.1160	.8961	23.1944	20.7841
23	1.1216	.8916	24.3104	21.6756
24	1.1272	.8872	25.4320	22.5629
25	1.1328	.8828	26.5591	23.4456
26	1.1385	.8784	27.6919	24.3240
27	1.1442	.8740	28.8304	25.1980
28	1.1499	.8697	29.9745	26.0677
29	1.1556	.8653	31.1244	26.9330
30	1.1614	.8610	32.2800	27.7941
31	1.1672	.8567	33.4414	28.6508
32	1.1730	.8525	34.6086	29.5033
33	1.1789	.8482	35.7817	30.3515
34	1.1848	.8440	36.9606	31.1955
35	1.1907	.8398	38.1454	32.0354
36	1.1967	.8356	39.3361	32.8710
37	1.2027	.8315	40.5328	33.7025
38	1.2087	.8274	41.7354	34.5299
39	1.2147	.8232	42.9441	35.3531
40	1.2208	.8191	44.1588	36.1722
41	1.2269	.8151	45.3796	36.9873
42	1.2330	.8110	46.6065	37.7983
43	1.2392	.8070	47.8306	38.6053
44	1.2454	.8030	49.0788	39.4082
45	1.2516	.7990	50.3242	40.2072
46	1.2579	.7950	51.5758	41.0022
47	1.2642	.7910	52.8337	41.7932
48	1.2705	.7871	54.0978	42.5803
49	1.2768	.7832	55.3683	43.3635
50	1.2832	.7793	56.6452	44.1428
55	1.3156	.7601	63.1200	47.9782
60	1.3488	.7414	69.7600	51.7020
65	1.3829	.7231	76.5800	55.2764
70	1.4178	.7053	83.5600	58.9364
75	1.4536	.6879	90.7200	62.4745
80	1.4903	.6710	98.0600	65.7988
85	1.5280	.6545	105.6000	69.1099
90	1.5665	.6383	113.3000	72.3268
95	1.6061	.6226	121.2200	75.4747
100	1.6467	.6073	129.3400	78.5449
105	1.6882	.5923	137.6400	81.5306
110	1.7309	.5777	146.1800	84.4531
115	1.7746	.5635	154.9200	87.2985
120	1.8194	.5496	163.8800	90.0736

1 Percent

n Years	1	2	3	4
1	1.0100	.9901	1.0000	.9901
2	1.0201	.9803	2.0100	1.9704
3	1.0303	.9706	3.0301	2.9410
4	1.0406	.9610	4.0604	3.9020
5	1.0510	.9515	5.1010	4.8534
6	1.0615	.9420	6.1520	5.7955
7	1.0721	.9327	7.2135	6.7282
8	1.0829	.9235	8.2857	7.6517
9	1.0937	.9143	9.3685	8.5660
10	1.1046	.9053	10.4622	9.4713
11	1.1157	.8963	11.5668	10.3676
12	1.1268	.8874	12.6825	11.2551
13	1.1381	.8787	13.8093	12.1337
14	1.1495	.8700	14.9474	13.0037
15	1.1610	.8613	16.0969	13.8651
16	1.1726	.8528	17.2579	14.7179
17	1.1843	.8444	18.4304	15.5622
18	1.1961	.8360	19.6147	16.3983
19	1.2081	.8277	20.8109	17.2260
20	1.2202	.8195	22.0190	18.0456
21	1.2324	.8114	23.2392	18.8570
22	1.2447	.8034	24.4716	19.6604
23	1.2572	.7954	25.7163	20.4558
24	1.2697	.7876	26.9735	21.2434
25	1.2824	.7798	28.2432	22.0232
26	1.2953	.7720	29.5256	22.7952
27	1.3082	.7644	30.8209	23.5596
28	1.3213	.7568	32.1291	24.3164
29	1.3345	.7493	33.4504	25.0658
30	1.3478	.7419	34.7849	25.8077
31	1.3613	.7346	36.1327	26.5423
32	1.3749	.7273	37.4941	27.2696
33	1.3887	.7201	38.8690	27.9897
34	1.4026	.7130	40.2577	28.7027
35	1.4166	.7059	41.6603	29.4086
36	1.4308	.6989	43.0769	30.1075
37	1.4451	.6920	44.5076	30.7995
38	1.4595	.6852	45.9527	31.4847
39	1.4741	.6784	47.4123	32.1630
40	1.4889	.6717	48.8864	32.8347
41	1.5038	.6650	50.3752	33.4997
42	1.5188	.6584	51.8790	34.1581
43	1.5340	.6519	53.3978	34.8100
44	1.5493	.6454	54.9318	35.4554
45	1.5648	.6391	56.4811	36.0945
46	1.5805	.6327	58.0459	36.7272
47	1.5963	.6265	59.6263	37.3537
48	1.6122	.6203	61.2226	37.9740
49	1.6283	.6141	62.8348	38.5881
50	1.6446	.6080	64.4632	39.1961
55	1.7284	.5786	72.8400	42.1430
60	1.8166	.5505	81.6600	44.9521
65	1.9093	.5238	90.9300	47.6247
70	2.0066	.4983	100.6600	50.1644
75	2.1090	.4742	110.9000	52.5841
80	2.2166	.4500	121.6600	54.8858
85	2.3296	.4292	132.9600	57.0742
90	2.4485	.4084	144.8500	59.1750
95	2.5733	.3886	157.3300	61.1394
100	2.7046	.3697	170.4600	63.0259
105	2.8425	.3518	184.2500	64.8197
110	2.9875	.3347	198.7500	66.5272
115	3.1399	.3185	213.9900	68.1518
120	3.3001	.3030	230.0100	69.6979

1½ Percent

n Years	1	2	3	4
1	1.0150	.9852	1.0000	.9852
2	1.0302	.9707	2.0150	1.9559
3	1.0457	.9563	3.0452	2.9122
4	1.0614	.9422	4.0909	3.8544
5	1.0773	.9283	5.1523	4.7826
6	1.0934	.9145	6.2290	5.6972
7	1.1098	.9010	7.3230	6.5982
8	1.1265	.8877	8.4328	7.4859
9	1.1434	.8746	9.5593	8.3605
10	1.1605	.8617	10.9027	9.2222
11	1.1779	.8489	11.8633	10.0711
12	1.1959	.8364	13.0412	10.9075
13	1.2130	.8240	14.2368	11.7315
14	1.2318	.8118	15.4504	12.5434
15	1.2502	.7999	16.6821	13.3432
16	1 2690	.7880	17.9324	14.1313
17	1 2880	.7764	19.2014	14.9076
18	1.3073	.7649	20.4894	15.6726
19	1.3270	.7536	21.7967	16.4262
20	1.3469	.7425	23.1237	17.1686
21	1.3671	.7315	24.4705	17.9001
22	1.3876	.7207	25.8376	18.6208
23	1.4084	.7100	27.2251	19.3309
24	1.4295	.6995	28.6335	20.0304
25	1.4509	.6892	30.0630	20.7196
26	1.4727	.6790	31.5140	21.3986
27	1.4948	.6690	32.9867	22.0676
28	1.5172	.6591	34.4815	22.7267
29	1.5400	.6494	35.9987	23.3761
30	1.5631	.6398	37.5387	24.0158
31	1.5865	.6303	39.1018	24.6461
32	1.6103	.6210	40.6883	25.2671
33	1.6345	.6118	42.2986	25.8790
34	1.6590	.6028	43.9331	26.4817
35	1.6839	.5939	45.5921	27.0756
36	1.7091	.5851	47.2760	27.6607
37	1.7348	.5764	48.9851	28.2371
38	1.7608	.5679	50.7199	28.8051
39	1.7872	.5595	52.4807	29.3646
40	1.8140	.5513	54.2679	29.9158
41	1.8412	.5431	56.0819	30.4590
42	1.8688	.5351	57.9231	30.9940
43	1.8969	.5272	59.7920	31.5212
44	1.9253	.5194	61.6889	32.0406
45	1.9542	.5117	63.6142	32.5523
46	1.9835	.5042	65.5684	33.0565
47	2.0133	.4967	67.5519	33.5532
48	2.0435	.4894	69.5652	34.0426
49	2.0741	.4821	71.6087	34.5247
50	2.1052	.4750	73.6828	34.9997
55	2.2679	.4409	84.5296	37.2715
60	2.4432	.4093	96.2147	39.3803
65	2.6320	.3799	108.8000	41.3373
70	2.8355	.3527	122.3640	43.1549
75	3.0546	.3274	136.9670	44.8409
80	3.2907	.3039	152.7110	46.4073
85	3.5450	.2821	169.6600	47.8603
90	3.8189	.2618	187.9300	49.2099
95	4.1141	.2431	207.6000	50.4618
100	4.4320	.2256	228.8030	51.6247
105	4.7746	.2094	251.6330	52.7036
110	5.1436	.1944	276.2380	53.7055
115	5.5411	.1805	302.7330	54.6351
120	5.9693	.1675	331.2880	55.4985

2 Percent

n Years	1	2	3	4
1	1.0200	.9804	1.0000	.9804
2	1.0404	.9612	2.0200	1.9416
3	1.0612	.9423	3.0604	2 8839
4	1.0824	.9238	4.1216	3.8077
5	1.1041	.9056	5.2040	4.7135
6	1.1262	.8880	6.3081	5.6014
7	1.1487	.8706	7.4343	6.4720
8	1.1717	.8535	8.5830	7.3255
9	1.1951	.8368	9.7546	8.1622
10	1.2190	.8203	10.9497	8.9826
11	1.2434	.8043	12.1687	9.7868
12	1.2682	.7885	13.4121	10.5753
13	1.2936	.7730	14.6803	11.3484
14	1.3195	.7579	15.9739	12.1062
15	1.3459	.7430	17.2934	12.8493
16	1.3728	.7284	18.6393	13.5777
17	1.4002	.7142	20.0121	14.2919
18	1.4282	.7002	21.4123	14.9920
19	1.4568	.6864	22.8406	15.6785
20	1.4859	.6730	24.2974	16.3514
21	1.5157	.6598	25.7833	17.0112
22	1.5460	.6468	27.2990	17.6580
23	1.5769	.6342	28.8450	18.2922
24	1.6084	.6217	30.4219	18.9139
25	1.6406	.6095	32.0303	19.5235
26	1.6734	.5976	33.6709	20 1210
27	1.7069	.5859	35.3443	20 7069
28	1.7410	.5744	37.0512	21 2813
29	1.7758	.5631	38.7922	21.8444
30	1.8114	.5521	40.5681	22.3965
31	1.8476	.5412	42.3794	22 9377
32	1.8845	.5306	44.2270	23 4683
33	1.9222	.5202	46.1116	23 9886
34	1.9607	.5100	48.0338	24.4986
35	1.9999	.5000	49.9945	24.9986
36	2.0399	.4902	51.9944	25.4888
37	2.0807	.4806	54.0343	25.9695
38	2.1223	.4712	56.1149	26.4406
39	2.1647	.4619	58.2372	26.9026
40	2.2080	.4529	60.4020	27.3555
41	2.2522	.4440	62.6100	27.7995
42	2.2972	.4353	64.8622	28.2348
43	2.3432	.4268	67.1595	28.6616
44	2.3901	.4184	69.5027	29.0800
45	2.4379	.4102	71.8927	29.4902
46	2.4866	.4022	74.3306	29.8923
47	2.5363	.3943	76.8172	30.2866
48	2.5871	.3865	79.3535	30 6731
49	2.6388	.3790	81.9406	31.0521
50	2.6916	.3715	84.5794	31.4236
55	2.9717	.3365	98.5865	33.1748
60	3.2810	.3048	114.0520	34.7609
65	3.6225	.2760	131.1250	36.1973
70	3.9995	.2500	149.9780	37.4986
75	4.4158	.2265	170.7900	38.6763
80	4.8754	.2051	193.7720	39.7445
85	5.3828	.1858	219.1400	40.7111
90	5.9431	.1683	247.1570	41.5869
95	6.5617	.1524	278.0850	42.3800
100	7.2446	.1380	312.2320	43.0984
105	7.9987	.1250	349 9300	43.7489
110	8.8312	.1132	391.5590	44.3382
115	9.7503	.1026	437.5150	44.8719
120	10.7652	.0929	488.2580	45.3554

2½ PERCENT

n Years	1	2	3	4
1	1.0250	.9756	1.0000	.9756
2	1.0506	.9518	2.0250	1.9274
3	1.0769	.9286	3.0756	2.8560
4	1.1038	.9060	4.1525	3.7620
5	1.1314	.8839	5.2563	4.6458
6	1.1597	.8623	6.3877	5.5081
7	1.1887	.8413	7.5474	6.3494
8	1.2184	.8207	8.7361	7.1701
9	1.2489	.8007	9.9545	7.9709
10	1.2801	.7812	11.2034	8.7521
11	1.3121	.7621	12.4835	9.5142
12	1.3449	.7436	13.7956	10.2578
13	1.3785	.7254	15.1404	10.9832
14	1.4130	.7077	16.5190	11.6909
15	1.4483	.6905	17.9319	12.3814
16	1.4845	.6736	19.3802	13.0550
17	1.5216	.6572	20.8047	13.7122
18	1.5597	.6412	22.3863	14.3534
19	1.5987	.6255	23.9460	14.9789
20	1.6386	.6103	25.5447	15.5892
21	1.6796	.5954	27.1833	16.1845
22	1.7216	.5809	28.8629	16.7654
23	1.7646	.5667	30.5844	17.3321
24	1.8087	.5529	32.3490	17.8850
25	1.8539	.5394	34.1578	18.4244
26	1.9003	.5262	36.0117	18.9506
27	1.9478	.5134	37.9120	19 4640
28	1.9965	.5009	39.8598	19 9649
29	2.0464	.4887	41.8563	20.4535
30	2.0976	.4767	43.9027	20.9303
31	2.1500	.4651	46.0003	21.3954
32	2.2038	.4538	48.1503	21.8492
33	2.2589	.4427	50.3540	22.2919
34	2.3153	.4319	52.6129	22.7238
35	2.3732	.4214	54.9282	23.1452
36	2.4325	.4111	57.3014	23.5563
37	2.4933	.4011	59.7339	23.9573
38	2.5557	.3913	62.2273	24.3486
39	2.6196	.3817	64.7830	24.7303
40	2.6851	.3724	67.4026	25.1028
41	2.7522	.3633	70.0876	25.4661
42	2.8210	.3545	72.8398	25.8206
43	2.8915	.3458	75.6608	26.1664
44	2.9638	.3374	78.5523	26.5038
45	3.0379	.3292	81.5161	26.8330
46	3.1139	.3211	84.5540	27.1542
47	3.1917	.3133	87.6679	27.4675
48	3.2715	.3057	90.8596	27.7732
49	3.3533	.2982	94.1311	28.0714
50	3.4371	.2909	97.4843	28.3623
55	3.8888	.2571	115 551	29.7140
60	4.3998	.2273	135.992	30.9087
65	4.9780	.2009	159.120	31.963
70	5.6321	.1775	185.284	32.898
75	6.3722	.1569	214.888	33.645
80	7.2096	.1387	248.383	34.452
85	8.1570	.1226	286.280	35.096
90	9.2289	.1084	329.154	35.666
95	10.4416	.0958	377.664	36.171
100	11.8137	.0846	432.549	36.614
105	13.3661	.0748	494.644	37.007
110	15.1226	.0661	564.902	37.355
115	17.1098	.0584	644.392	37.664
120	19.3581	.0517	734.326	37.934

3 Percent

n Years	1	2	3	4
1	1.0300	.9709	1.0000	.9709
2	1.0609	.9426	2.0300	1.9135
3	1.0927	.9151	3.0909	2.8286
4	1.1255	.8885	4.1836	3.7171
5	1.1593	.8626	5.3091	4.5797
6	1.1941	.8375	6.4684	5.4172
7	1.2299	.8131	7.6625	6.2303
8	1.2668	.7894	8.8923	7.0197
9	1.3048	.7664	10.1591	7.7861
10	1.3439	.7441	11.4639	8.5302
11	1.3842	.7224	12.8075	9.2526
12	1.4258	.7014	14.1920	9.9540
13	1.4685	.6810	15.6178	10.6350
14	1.5126	.6611	17.0863	11.2961
15	1.5580	.6419	18.5989	11.9379
16	1.6047	.6232	20.1569	12.5611
17	1.6528	.6050	21.7616	13.1661
18	1.7024	.5874	23.4144	13.7535
19	1.7535	.5703	25.1169	14.3238
20	1.8061	.5537	26.8704	14.8775
21	1.8603	.5375	28.6765	15.4150
22	1.9161	.5219	30.5368	15.9369
23	1.9736	.5067	32.4529	16.4436
24	2.0328	.4919	34.4265	16.9325
25	2.0938	.4776	36.4593	17.4131
26	2.1566	.4637	38.5530	17.8768
27	2.2213	.4502	40.7096	18.3270
28	2.2879	.4371	42.9309	18.7641
29	2.3566	.4243	45.2189	19.1885
30	2.4273	.4120	47.5754	19.6004
31	2.5001	.4000	50.0027	20.0004
32	2.5751	.3883	52.5028	20.3888
33	2.6523	.3770	55.0778	20.7658
34	2.7319	.3660	57.7302	21.1318
35	2.8139	.3554	60.4621	21.4872
36	2.8983	.3450	63.2759	21.8323
37	2.9852	.3350	66.1742	22.1672
38	3.0748	.3252	69.1594	22.4925
39	3.1670	.3158	72.2342	22.8082
40	3.2620	.3066	75.4013	23.1148
41	3.3599	.2976	78.6633	23.4124
42	3.4607	.2890	82.0232	23.7014
43	3.5645	.2805	85.4839	23.9819
44	3.6715	.2724	89.0484	24.2543
45	3.7816	.2644	92.7199	24.5187
46	3.8950	.2567	96.5015	24.7754
47	4.0119	.2493	100.3965	25.0247
48	4.1323	.2420	104.4084	25.2667
49	4.2562	.2350	108.5406	25.5017
50	4.3839	.2281	112.7969	25.7298
55	5.0821	.1968	136.072	26.7744
60	5.8916	.1697	163.053	27.6756
65	6.8300	.1464	194.333	28.452
70	7.9178	.1263	230.594	29.123
75	9.1789	.1089	272.630	29.702
80	10.6409	.0940	321.363	30.201
85	12.3357	.0811	377.857	30.701
90	14.3005	.0699	443.349	31.002
95	16.5782	.0603	519.273	31.323
100	19.2186	.0520	607.288	31.599
105	22.2797	.0449	700.323	31.838
110	25.8282	.0387	827.608	32.043
115	29.9420	.0334	964.733	32.220
120	34.7110	.0288	1123.70	32.373

3½ Percent

n Years	1	2	3	4
1	1.0350	.9662	1.0000	.9662
2	1.0712	.9335	2.0350	1.8997
3	1.1087	.9019	3.1062	2.8016
4	1.1475	.8714	4.2149	3.6731
5	1.1877	.8420	5.3625	4.5151
6	1.2293	.8135	6.5502	5.3286
7	1.2723	.7860	7.7794	6.1145
8	1.3168	.7594	9.0517	6.8740
9	1.3629	.7337	10.3685	7.6077
10	1.4106	.7089	11.7314	8.3166
11	1.4600	.6849	13.1420	9.0016
12	1.5111	.6618	14.6020	9.6633
13	1.5640	.6394	16.1130	10.3027
14	1.6187	.6178	17.6770	10.9205
15	1.6753	.5969	19.2957	11.5174
16	1.7340	.5767	20.9710	12.0941
17	1.7947	.5572	22.7050	12.6513
18	1.8575	.5384	24.4997	13.1897
19	1.9225	.5202	26.3572	13.7098
20	1.9898	.5026	28.2797	14.2124
21	2.0594	.4856	30.2695	14.6980
22	2.1315	.4692	32.3289	15.1671
23	2.2061	.4533	34.4604	15.6204
24	2.2833	.4380	36.6665	16.0574
25	2.3632	.4231	38.9499	16.4815
26	2.4460	.4088	41.3131	16.8904
27	2.5316	.3950	43.7591	17.2854
28	2.6202	.3817	46.2906	17.6670
29	2.7119	.3687	48.9108	18.0358
30	2.8068	.3563	51.6227	18.3920
31	2.9050	.3442	54.4295	18.7363
32	3.0067	.3326	57.3345	19.0689
33	3.1119	.3213	60.3412	19.3902
34	3.2209	.3105	63.4532	19.7007
35	3.3336	.3000	66.6740	20.0007
36	3.4503	.2898	70.0076	20.2905
37	3.5710	.2800	73.4579	20.5705
38	3.6960	.2706	77.0289	20.8411
39	3.8254	.2614	80.7249	21.1025
40	3.9593	.2526	84.5503	21.3551
41	4.0978	.2440	88.5095	21.5991
42	4.2413	.2358	92.6074	21.8349
43	4.3897	.2278	96.8487	22.0627
44	4.5433	.2201	101.2383	22.2828
45	4.7024	.2127	105.7817	22.4955
46	4.8669	.2055	110.4840	22.7009
47	5.0373	.1985	115.3510	22.8994
48	5.2136	.1918	120.3883	23.0912
49	5.3961	.1853	125.6018	23.2766
50	5.5849	.1791	130.9979	23.4556
55	6.6331	.1508	160.947	24.2641
60	7.8781	.1269	196.517	24.9447
65	9.3567	.1069	238.763	25.5168
70	11.1128	.0900	288.938	26.0004
75	13.1986	.0758	348.531	26.4067
80	15.6757	.0638	419.307	26.7488
85	18.6179	.0537	503.368	27.0368
90	22.1122	.0452	603.205	27.2793
95	26.2623	.0381	721.780	27.4798
100	31.1914	.0321	862.612	27.6554
105	37.0456	.0270	1029.874	27.8002
110	43.9986	.0227	1228.53	27.9221
115	52.2565	.0191	1464.471	28.0247
120	62.0643	.0161	1744.69	28.1111

4 PERCENT

n Years	1	2	3	4
1	1.0400	.9615	1.0000	.9615
2	1.0816	.9246	2.0400	1.8861
3	1.1249	.8890	3.1216	2.7751
4	1.1699	.8548	4.2465	3.6299
5	1.2167	.8219	5.4163	4.4518
6	1.2653	.7903	6.6330	5.2421
7	1.3159	.7599	7.8983	6.0021
8	1.3686	.7307	9.2142	6.7327
9	1.4233	.7026	10.5828	7.4353
10	1.4802	.6756	12.0061	8.1109
11	1.5395	.6496	13.4864	8.7605
12	1.6010	.6246	15.0258	9.3851
13	1.6651	.6006	16.6268	9.9856
14	1.7315	.5775	18.2919	10.5631
15	1.8009	.5553	20.0236	11.1184
16	1.8730	.5339	21.8245	11.6523
17	1.9479	.5134	23.6975	12.1657
18	2.0258	.4936	25.6454	12.6593
19	2.1068	.4746	27.6712	13.1339
20	2.1911	.4564	29.7781	13.5903
21	2.2788	.4388	31.9692	14.0292
22	2.3699	.4220	34.2480	14.4511
23	2.4647	.4057	36.6179	14.8568
24	2.5633	.3901	39.0826	15.2470
25	2.6658	.3751	41.6459	15.6221
26	2.7725	.3607	44.3117	15.9828
27	2.8834	.3468	47.0842	16.3296
28	2.9987	.3335	49.9676	16.6631
29	3.1187	.3207	52.9663	16.9837
30	3.2434	.3083	56.0849	17.2920
31	3.3731	.2965	59.3283	17.5885
32	3.5081	.2851	62.7015	17.8736
33	3.6484	.2741	66.2095	18.1476
34	3.7943	.2636	69.8579	18.4112
35	3.9461	.2534	73.6522	18.6646
36	4.1039	.2437	77.5983	18.9083
37	4.2681	.2343	81.7022	19.1426
38	4.4388	.2253	85.7903	19.3679
39	4.6164	.2166	90.4091	19.5845
40	4.8010	.2083	95.0255	19.7928
41	4.9931	.2003	99.8265	19.9931
42	5.1928	.1926	104.8200	20.1856
43	5.4005	.1852	110.0124	20.3708
44	5.6165	.1780	115.4129	20.5488
45	5.8412	.1712	121.0294	20.7200
46	6.0748	.1646	126.8706	20.8847
47	6.3178	.1583	132.9454	21.0429
48	6.5705	.1522	139.2632	21.1951
49	6.8333	.1463	145.8337	21.3415
50	7.1067	.1407	152.6671	21.4822
55	8.6464	.1157	191.159	22.1086
60	10.5196	.0951	237.991	22.6235
65	12.7987	.0781	294.967	23.0466
70	15.5716	.0642	364.290	23.3945
75	18.9453	.0528	448.642	23.6281
80	23.0498	.0434	551.245	23.9154
85	28.0436	.0357	676.090	24.1085
90	34.1193	.0293	827.983	24.2673
95	41.5114	.0241	1012.785	24.3977
100	50.5049	.0198	1237.622	24.5050
105	61.4470	.0163	1511.175	24.5931
110	74.7597	.0134	1843.992	24.6656
115	90.9566	.0110	2248.915	24.7251
120	110.663	.0090	2741.558	24.7741

4½ Percent

n Years	1	2	3	4
1	1.0450	.9569	1.0000	.9569
2	1.0920	.9157	2.0450	1.8727
3	1.1412	.8765	3.1370	2.7490
4	1.1925	.8386	4.2782	3.5875
5	1.2462	.8022	5.4707	4.3900
6	1.3023	.7679	6.7169	5.1579
7	1.3609	.7348	8.0192	5.8927
8	1.4221	.7032	9.3800	6.5959
9	1.4861	.6729	10.8021	7.2688
10	1.5530	.6439	12.2882	7.9125
11	1.6229	.6162	13.8412	8.5289
12	1.6959	.4897	15.4640	9.1186
13	1.7722	.5643	17.1599	9.6829
14	1.8519	.5400	18.9321	10.2229
15	1.9353	.5167	20.7841	10.7395
16	2.0224	.4945	22.7193	11.2340
17	2.1134	.4732	24.7417	11.7072
18	2.2085	.4528	26.8551	12.1600
19	2.3079	.4333	29.0634	12.5933
20	2.4117	.4146	31.3716	13.0079
21	2.5202	.3968	33.7831	13.4047
22	2.6337	.3797	36.3034	13.7844
23	2.7522	.3634	38.9370	14.1478
24	2.8760	.3477	41.6892	14.4955
25	3.0054	.3327	44.5652	14.8282
26	3.1407	.3184	47.5706	15.1466
27	3.2820	.3047	50.7113	15.4513
28	3.4279	.2916	53.9933	15.7429
29	3.5840	.2790	57.4230	16.0219
30	3.7453	.2670	61.0071	16.2889
31	3.9139	.2555	64.7524	16.5444
32	4.0900	.2445	68.6662	16.7889
33	4.2740	.2340	72.7562	17.0229
34	4.4664	.2239	77.0303	17.2468
35	4.6673	.2143	81.4966	17.4610
36	4.8774	.2050	86.1640	17.6660
37	5.0969	.1962	91.0413	17.8622
38	5.3262	.1878	96.1382	18.0500
39	5.5659	.1797	101.4644	18.2297
40	5.8164	.1719	107.0303	18.4016
41	6.0781	.1645	112.8467	18.5661
42	6.3516	.1574	118.9248	18.7235
43	6.6374	.1507	125.2764	18.8742
44	6.9361	.1442	131.9138	19.0184
45	7.2482	.1380	138.8500	19.1563
46	7.5744	.1320	146.0982	19.2884
47	7.9153	.1263	153.6726	19.4147
48	8.2715	.1209	161.5879	19.5356
49	8.6437	.1157	169.8594	19.6513
50	9.0326	.1107	178.5030	19.7620
55	11.2563	.0888	227.9180	20.2480
60	14.0274	.0713	289.4980	20.6380
65	17.4807	.0572	366.2380	20.9509
70	21.7841	.0459	461.8700	21.2021
75	27.1470	.0368	581.2670	21.4118
80	33.8301	.0296	729.5580	21.5653
85	42.1585	.0237	914.6330	21.6951
90	52.5371	.0190	1145.2700	21.7992
95	65.4708	.0153	1432.6840	21.8828
100	81.5885	.0123	1790.8600	21.9499
105	101.674	.0098	2237.2000	22.0036
110	126.704	.0079	2793.4300	22.0468
115	157.897	.0063	3486.6000	22.0815
120	196.768	.0051	4350.4000	22.1093

5 Percent

n Years	1	2	3	4
1	1.0500	.9524	1.0000	.9524
2	1.1025	.9070	2.0500	1.8594
3	1.1576	.8638	3.1525	2.7232
4	1.2155	.8227	4.3101	3.5460
5	1.2763	.7835	5.5256	4.3295
6	1.3401	.7462	6.8019	5.0757
7	1.4071	.7107	8.1420	5.7864
8	1.4775	.6768	9.5491	6.4632
9	1.5513	.6446	11.0266	7.1078
10	1.6289	.6139	12.5779	7.7217
11	1.7103	.5847	14.2068	8.3064
12	1.7959	.5568	15.9171	8.8623
13	1.8856	.5303	17.7130	9.3936
14	1.9799	.5051	19.5986	9.8986
15	2.0789	.4810	21.5786	10.3797
16	2.1829	.4581	23.6575	10.8378
17	2.2920	.4363	25.8404	11.2741
18	2.4066	.4155	28.1324	11.6896
19	2.5270	.3957	30.5390	12.0853
20	2.6533	.3769	33.0660	12.4622
21	2.7860	.3589	35.7193	12.8212
22	2.9253	.3418	38.5052	13.1630
23	3.0715	.3256	41.4305	13.4886
24	3.2251	.3101	44.5020	13.7986
25	3.3864	.2953	47.7271	14.0939
26	3.5557	.2812	51.1135	14.3752
27	3.7335	.2678	54.6691	14.6430
28	3.9201	.2551	58.4026	14.8981
29	4.1161	.2429	62.3227	15.1411
30	4.3219	.2314	66.4388	15.3725
31	4.5380	.2204	70.7608	15.5928
32	4.7649	.2099	75.2988	15.8027
33	5.0032	.1999	80.0638	16.0025
34	5.2533	.1904	85.0670	16.1929
35	5.5160	.1813	90.3203	16.3742
36	5.7918	.1727	95.8363	16.5469
37	6.0814	.1644	101.6281	16.7113
38	6.3855	.1566	107.7095	16.8679
39	6.7048	.1491	114.0950	17.0170
40	7.0400	.1420	120.7998	17.1591
41	7.3920	.1353	127.8398	17.2944
42	7.7616	.1288	135.2318	17.4232
43	8.1497	.1227	142.9933	17.5459
44	8.5572	.1169	151.1430	17.6628
45	8.9850	.1113	159.7002	17.7741
46	9.4343	.1060	168.6852	17.8801
47	9.9060	.1009	178.1194	17.9810
48	10.4013	.0961	188.0254	18.0772
49	10.9213	.0916	198.4267	18.1687
50	11.4674	.0872	209.3480	18.2559
55	14.6356	.0683	272.7130	18.6335
60	18.6792	.0535	353.5840	18.9293
65	23.8399	.0419	456.7980	19.1191
70	30.4264	.0329	588.5290	19.3427
75	38.8327	.0257	756.6540	19.4849
80	49.5614	.0202	971.2290	19.5965
85	63.2544	.0158	1245.0880	19.6838
90	80.7304	.0124	1594.6100	19.7523
95	103.035	.0097	2040.7000	19.8058
100	131.501	.0076	2610.0300	19.8479
105	167.833	.0060	3336.6600	19.8808
110	214.202	.0047	4264.0300	19.9066
115	273.382	.0037	5447.6400	19.9268
120	348.912	.0029	6958.2400	19.9427

5½ Percent

n Years	1	2	3	4
1	1.0550	.9479	1.0000	.9479
2	1.1130	.8985	2.0550	1.8463
3	1.1742	.8516	3.1680	2.6979
4	1.2388	.8072	4.3423	3.5052
5	1.3070	.7651	5.5811	4.2703
6	1.3788	.7252	6.8881	4.9955
7	1.4547	.6854	8.2669	5.6830
8	1.5347	.6516	9.7216	6.3346
9	1.6191	.6176	11.2563	6.9522
10	1.7081	.5854	12.8754	7.5376
11	1.8021	.5549	14.5835	8.0925
12	1.9012	.5260	16.3856	8.6185
13	2.0058	.4986	18.2868	9.1171
14	2.1161	.4726	20.2926	9.5896
15	2.2325	.4479	22.4087	10.0376
16	2.3553	.4246	24.6411	10.4622
17	2.4848	.4024	26.9964	10.8646
18	2.6215	.3815	29.4812	11.2461
19	2.7656	.3616	32.1027	11.6077
20	2.9178	.3427	34.8683	11.9504
21	3.0782	.3249	37.7861	12.2752
22	3.2275	.3079	40.8643	12.5832
23	3.4262	.2919	44.1118	12.8750
24	3.6146	.2767	47.5380	13.1517
25	3.8134	.2622	51.1526	13.4139
26	4.0231	.2486	54.9660	13.6625
27	4.2444	.2356	58.9891	13.8981
28	4.4778	.2233	63.2335	14.1214
29	4.7241	.2117	67.7114	14.3331
30	4.9840	.2006	71.4355	14.5337
31	5.2581	.1902	77.4194	14.7239
32	5.5473	.1803	82.6775	14.9042
33	5.8524	.1709	88.2248	15.0751
34	6.1742	.1620	94.0771	15.2370
35	6.5138	.1535	100.2514	15.3906
36	6.8721	.1455	106.7652	15.5361
37	7.2501	.1379	113.6373	15.6740
38	7.6488	.1307	120.8873	15.8047
39	8.0695	.1239	128.5361	15.9287
40	8.5133	.1175	136.6056	16.0461
41	8.9815	.1113	145.1189	16.1575
42	9.4755	.1055	154.1005	16.2630
43	9.9967	.1000	163.5760	16.3630
44	10.5465	.0948	173.5727	16.4579
45	11.1266	.0899	184.1192	16.5477
46	11.7385	.0852	195.2457	16.6329
47	12.3841	.0807	206.9842	16.7137
48	13.0653	.0765	219.3684	16.7902
49	13.7838	.0725	232.4336	16.8628
50	14.5420	.0688	246.2175	16.9315
55	19.0046	.0526	327.3563	17.2251
60	24.8381	.0403	433.4200	17.4498
65	32.4623	.0308	572.0364	17.6216
70	43.4150	.0230	771.1818	17.7630
75	56.7414	.0176	1,013.4800	17.8614
80	72.4703	.0138	1,299.4600	17.9309
85	94.7152	.0106	1,703.9127	17.9898
90	123.7883	.0081	2,232.5145	18.0349
95	161.7855	.0062	2,923.3727	18.0694
100	211.4463	.0047	3,826.2963	18.0958
105	276.3503	.0036	5,006.3691	18.1160
110	361.2768	.0028	6,550.4873	18.1315
115	472.0413	.0021	8,564.3873	18.1433
120	616.9357	.0016	11,198.8309	18.1523

6 Percent

n Years	1	2	3	4
1	1.0600	.9434	1.0000	.9434
2	1.1236	.8900	2.0600	1.8334
3	1.1910	.8396	3.1836	2.6730
4	1.2625	.7921	4.3746	3.4651
5	1.3382	.7473	5.6371	4.2124
6	1.4185	.7050	6.9753	4.9173
7	1.5036	.6651	8.3938	5.5824
8	1.5938	.6274	9.8975	6.2098
9	1.6895	.5919	11.4913	6.8017
10	1.7908	.5584	13.1808	7.3601
11	1.8983	.5268	14.9716	7.8869
12	2.0122	.4970	16.8699	8.3838
13	2.1329	.4688	18.8821	8.8527
14	2.2609	.4423	21.0151	9.2950
15	2.3966	.4173	23.2760	9.7122
16	2.5404	.3936	25.6725	10.1059
17	2.6928	.3714	28.2129	10.4772
18	2.8543	.3503	30.9057	10.8276
19	3.0256	.3305	33.7600	11.1581
20	3.2071	.3118	36.7856	11.4699
21	3.3996	.2942	39.9927	11.7641
22	3.6035	.2775	43.3923	12.0416
23	3.8197	.2618	46.9958	12.3034
24	4.0489	.2470	50.8156	12.5504
25	4.2919	.2330	54.8645	12.7834
26	4.5494	.2198	59.1564	13.0032
27	4.8223	.2074	63.7058	13.2105
28	5.1117	.1956	68.5281	13.4062
29	5.4184	.1846	73.6398	13.5907
30	5.7435	.1741	79.0582	13.7648
31	6.0881	.1643	84.8017	13.9291
32	6.4534	.1550	90.8898	14.0840
33	6.8406	.1462	97.3432	14.2302
34	7.2510	.1379	104.1838	14.3681
35	7.6861	.1301	111.4348	14.4982
36	8.1473	.1227	119.1209	14.6210
37	8.6361	.1158	127.2681	14.7368
38	9.1543	.1092	135.9042	14.8460
39	9.7035	.1031	145.0585	14.9491
40	10.2857	.0972	154.7620	15.0463
41	10.9029	.0917	165.0477	15.1380
42	11.5570	.0865	175.9505	15.2245
43	12.2505	.0816	187.5076	15.3062
44	12.9855	.0770	199.7580	15.3832
45	13.7646	.0727	212.7435	15.4558
46	14.5905	.0685	226.5081	15.5244
47	15.4659	.0647	241.0985	15.5890
48	16.3939	.0610	256.5645	15.6500
49	17.3775	.0575	272.9584	15.7076
50	18.4202	.0543	290.3359	15.7619
55	24.6507	.0406	394.1783	15.9905
60	32.9883	.0303	533.1383	16.1611
65	44.1458	.0226	719.0966	16.2891
70	59.0772	.0169	967.9533	16.3845
75	79.0587	.0126	1,300.9783	16.4558
80	105.7985	.0095	1,746.6416	16.5091
85	141.5287	.0071	2,343.0450	16.5489
90	189.4698	.0053	3,141.1633	16.5787
95	253.5538	.0039	4,209.2300	16.6009
100	339.3125	.0029	5,638.5416	16.6175
105	454.0770	.0022	7,551.2833	16.6299
110	607.6591	.0016	10,110.9850	16.6392
115	813.1867	.0012	13,536.4450	16.6461
120	1088.2280	.0009	18,120.4667	16.6513

7 Percent

n Years	1	2	3	4
1	1.0700	.9346	1.0000	.9328
2	1.1449	.8736	2.0700	1.8043
3	1.2250	.8163	3.2142	2.6228
4	1.3108	.7629	4.4400	3.3857
5	1.4026	.7130	5.7514	4.0986
6	1.5007	.6663	7.3529	4.7657
7	1.6058	.6227	8.6542	5.3886
8	1.7182	.5820	10.2600	5.9700
9	1.8385	.5439	11.9786	6.5143
10	1.9671	.5083	13.8159	7.0228
11	2.1049	.4751	15.7843	7.4971
12	2.2522	.4440	17.8886	7.9414
13	2.4098	.4150	20.1400	8.3557
14	2.5785	.3878	22.5500	8.7442
15	2.7590	.3624	25.1286	9.1071
16	2.9522	.3387	27.8886	9.4457
17	3.1588	.3161	30.8400	9.7686
18	3.3800	.2959	34.0000	10.0571
19	3.6165	.2765	37.3786	10.3343
20	3.8697	.2584	40.9528	10.5928
21	4.1406	.2415	44.8657	10.8343
22	4.4304	.2257	49.0057	11.0600
23	4.7405	.2109	53.4343	11.2714
24	5.0724	.1971	55.3200	11.4685
25	5.4275	.1842	63.2500	11.6528
26	5.8075	.1722	68.6786	11.8242
27	6.2140	.1609	74.4857	11.9857
28	6.6490	.1504	80.7000	12.1357
29	7.1144	.1406	87.3346	12.2757
30	7.6124	.1314	94.4628	12.4071
31	8.1452	.1228	102.0742	12.5300
32	8.7154	.1147	110.2700	12.6457
33	9.3255	.1072	118.9500	12.7528
34	9.9783	.1002	128.2618	12.8528
35	10.6768	.0937	138.2400	12.9457
36	11.4241	.0875	148.9157	13.0343
37	12.2239	.0818	160.3414	13.1157
38	13.0795	.0765	172.5642	13.1914
39	13.9950	.0715	185.6428	13.2628
40	14.9747	.0668	199.6386	13.3300
41	16.0230	.0624	214.6143	13.3928
42	17.1446	.0583	230.6371	13.4514
43	18.3448	.0545	247.7828	13.5057
44	19.6290	.0509	266.1428	13.5571
45	21.0030	.0476	285.7571	13.6043
46	22.4332	.0445	306.1886	13.6485
47	24.0463	.0416	329.2328	13.6900
48	25.7888	.0387	354.1257	13.7314
49	27.5306	.0363	379.0086	13.7657
50	29.4577	.0339	406.5386	13.8000
55	41.3162	.0242	575.9458	13.9385
60	57.9482	.0173	813.5458	14.0371
65	81.2755	.0123	1,146.7928	14.1085
70	113.9929	.0088	1,614.1844	14.1585
75	159.8823	.0062	2,141.1757	14.1959
80	224.2440	.0045	2,269.7471	14.2200
85	314.5138	.0032	3,160.6285	14.2385
90	441.1230	.0023	4,478.7682	14.2514
95	618.7000	.0016	6,287.4714	14.2614
100	867.7600	.0011	8,824.2857	14.2685
105	1217.0812	.0008	12,382.2855	14.2728
110	1707.0235	.0006	17,372.5886	14.2757
115	2394.1978	.0004	24,371.7642	14.2785
120	3357.9923	.0003	34,188.5400	14.2800

8 Percent

n Years	1	2	3	4
1	1.0800	.9259	1.0000	.9250
2	1.1664	.8573	2.0800	1.7825
3	1.2597	.7938	3.2463	2.5762
4	1.3605	.7350	4.5062	3.3112
5	1.4693	.6806	5.8366	3.9912
6	1.5869	.6302	7.3362	4.6212
7	1.7138	.5840	8.9225	5.1987
8	1.8509	.5403	10.6363	5.7450
9	1.9990	.5002	12.4875	6.2462
10	2.1589	.4632	14.4862	6.7087
11	2.3317	.4289	16.6463	7.1375
12	2.5182	.3971	18.9775	7.5350
13	2.7196	.3676	21.4950	7.9037
14	2.9372	.3405	24.2150	8.2425
15	3.1722	.3152	27.1525	8.5587
16	3.4260	2910	30.3250	8.8513
17	3.7000	.2703	33.7500	9.1200
18	3.9960	.2502	37.4500	9.3712
19	4.3157	.2317	41.4463	9.6025
20	4.6610	2145	45.7625	9.8175
21	5.0339	.1987	50.4237	10.0150
22	5.4366	1839	55.4575	10.2000
23	5.8716	.1703	60.8950	10.3700
24	6.3413	.1577	66.7663	10.5275
25	6.8486	.1460	73.1075	10.6737
26	7.3964	.1352	79.9800	10.8087
27	7.9882	.1252	87.3525	10.9337
28	8.6272	.1159	95.3400	11.0500
29	9.3174	.1073	103.9675	11.1575
30	10.0629	.0994	113.2862	11.2562
31	10.8678	.0920	123.3475	11.3487
32	11.7371	.0852	134.2138	11.4337
33	12.6763	.0789	145.9537	11.5125
34	13.6904	.0730	158.6300	11.5862
35	14.7853	.0676	172.3163	11.6537
36	15.9684	.0626	187.1050	11.7162
37	17.2460	.0580	203.0750	11.7737
38	18.6249	.0537	220.3113	11.8275
39	20.1159	.0497	238.9488	11.8775
40	21.7250	.0460	259.0625	11.9237
41	23.4630	.0426	280.7875	11.9662
42	25.3400	.0395	304.2500	12.0050
43	27.3672	.0365	329.5900	12.0425
44	29.5567	.0338	356.9588	12.0762
45	31.9213	.0313	386.5163	12.1075
46	34.4750	.0290	418.4375	12.1362
47	37.2330	.0269	452.9125	12.1625
48	40.2117	.0249	490.1463	12.1875
49	43.4207	.0230	530.2588	12.2112
50	46.9029	.0213	573.7863	12.2325
55	68.9160	.0145	848.9500	12.3175
60	101.2605	.0099	1,253.2563	12.3750
65	148.7849	.0067	1,847.3113	12.4150
70	218.6150	.0046	2,720.1875	12.4412
75	321.2177	.0031	4,002.7213	12.4600
80	471.9761	.0021	5,887.2013	12.4725
85	693.4888	.0014	8,656.1100	12.4812
90	1,018.9649	.0010	12,724.5613	12.4862
95	1,497.1993	.0007	18,702.4913	12.4900
100	2,199.8838	.0005	27,486.0475	12.4925
105	3,232.3656	.0003	40,392.0700	12.4950
110	4,749.4130	.0002	59,355.1625	12.4962
115	6,978.4677	.0001	87,218.3463	12.4975
120	10,253.6792	.0001	128,158.4900	12.4989

10 Percent

n Years	1	2	3	4
1	1.1000	.9091	1.0000	0.908
2	1.2100	.8264	2.1000	1.735
3	1.3310	.7513	3.3100	2.486
4	1.4641	.6830	4.6410	3.169
5	1.6105	.6209	6.1050	3.790
6	1.7716	.5645	7.7160	4.354
7	1.9487	.5132	9.4870	4.867
8	2.1436	.4665	11.4360	5.334
9	2.3580	.4241	13.5800	5.758
10	2.5938	.3855	15.9380	6.144
11	2.8531	.3505	18.5310	6.494
12	3.1385	.3186	21.3850	6.813
13	3.4523	.2897	24.5230	7.102
14	3.7976	.2633	27.9760	7.366
15	4.1773	.2394	31.7730	7.605
16	4.5950	.2176	35.9500	7.823
17	5.0545	.1978	40.5450	8.021
18	5.5600	.1799	45.6000	8.200
19	6.1160	.1635	51.1600	8.364
20	6.7276	.1486	57.2760	8.513
21	7.4004	.1351	64.0040	8.648
22	8.1404	.1228	71.4040	8.771
23	8.9545	.1117	79.5450	8.882
24	9.8500	.1015	88.5000	8.984
25	10.8349	.0923	98.3490	9.076
26	11.9184	.0839	109.1840	9.160
27	13.1103	.0763	121.1030	9.236
28	14.4213	.0693	134.2130	9.306
29	15.8634	.0630	148.6340	9.369
30	17.4498	.0573	164.4980	9.426
31	19.1948	.0521	181.9480	9.478
32	21.1143	.0474	201.1430	9.525
33	23.2257	.0431	222.2570	9.568
34	25.5483	.0391	245.4830	9.608
35	28.1032	.0356	271.0320	9.643
36	30.9135	.0324	299.1350	9.675
37	34.0049	.0294	330.0490	9.705
38	37.4054	.0273	364.0540	9.726
39	41.1460	.0243	401.4600	9.756
40	45.2605	.0221	442.6050	9.778
41	49.7866	.0201	487.8660	9.798
42	54.7655	.0183	537.6550	9.816
43	60.2420	.0166	592.4200	9.833
44	66.2662	.0151	652.6620	9.848
45	72.8928	.0137	718.9280	9.862
46	80.1822	.0125	791.8220	9.874
47	88.2004	.0113	872.0040	9.886
48	97.0207	.0103	960.2070	9.896
49	106.7228	.0094	1,057.2280	9.905
50	117.3926	.0085	1,163.9260	9.914
55	189.0668	.0053	1,880.6680	9.946
60	304.4944	.0033	3,034.9440	9.966
65	490.3932	.0020	4,893.9320	9.979
70	789.7876	.0013	7,887.8760	9.986
75	1,271.9648	.0008	12,709.6480	9.991
80	2,048.5188	.0005	20,475.1880	9.994
85	3,299.1742	.0003	32,981.7420	9.996
90	5,313.3659	.0002	53,123.6590	9.997
95	8,557.2549	.0001	85,562.5490	9.998
100	13,781.6139	.00007	137,806.1390	9.9992
105	22,195.5102	.00005	221,945.1020	9.9994
110	35,746.1983	.00003	357,451.9830	9.9996
115	57,569.8666	.00002	575,688.6660	9.9997
120	92,717.0213	.00001	927,160.2130	9.9998

INDEX

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E

F